CRIMSON VIPER

PHASE IV: FIELD EXPERIMENTATION

VENUE REPORT

AND CV14 COMBINED REPORT

SEPTEMBER 2014

CHAO SAMRAM, THAILAND

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The Crimson Viper Field Experiment is conducted annually between the Royal Thai Ministry of Defence, Defence Science and Technology Department, and U.S. Pacific Command Science and Technology Office. Crimson Viper is executed under the ambit of the Thai-American Consultations Talks Science and Technology Committee. The purpose of CV14 was to experiment with leading edge technologies, and proposed Concepts of Operation, in relevant operational conditions to gather feedback. CV14 field experimentation provided a platform to support collaboration and promote interoperability between Royal Thai Armed Forces and U.S. PACOM, confirm technology maturity prior to introducing to war-fighters, and provide candidate technologies for longer term Royal Thai Armed Forces assessment. Technologies covered in this report include the multiple solar and renewable energy technologies, Emergency Pop Up Phone and Power Network, the Smart-Direct Assessment in Real Time, Persistent Ground Surveillance Tower, the Solar Powered Solid State Refrigerator, the First Response Freshwater Purifier, Cold Form Steel, Improvised Explosive Devise Network Analysis, and the Standoff Covert Eye-Safe Explosives Detection System.

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This report provides information on the nine technologies that were demonstrated and/or assessed during Crimson Viper 2014 (CV14) Field Experiment Phase IV as part of the ongoing experimentation engagement and partnership between U.S. Pacific Command and Royal Thai Ministry of Defence (MOD) Defence Science and Technology Department (DSTD). This document provides some limited observations and feedback gathered by the Technology Experimentation Center (TEC) and Office of Naval Research Reserve Component (ONR-RC) and does not represent the formal position of the U.S. Pacific Command (PACOM) or Department of the Navy.

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Shujie Chang, P.E.
Director, TEC

Vandiver, Greg
Science Advisor, PACOM

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ACRONYMS

AC	Alternating Current
AFN	Agean Federation Network
AGIG	Airborne Global Information Grid
AGL	above ground level
AIS	Automated Information System
C2	command and control
CGCS	common ground control station
CONEX	container express
COP	common operating picture
CV	Crimson Viper
DART	Direct Assessment in Real Time
DoD	Department of Defense
DRG	Digital Results Group
EO	electro-optical
ePoP	Emergency Pop-Up Phone and Power Network
FLIR	forward-looking infrared also part of a company name (FLIR Systems, Incorporated)
FMV	full-motion video
FOB	forward operating base
GCS	ground control station
GFCI	Ground Fault Circuit Interrupter
GFU	ground fixed unit
HADR	Humanitarian Assistance Disaster Relief
HD	high definition
IED	Improvised Explosive Device
IP	Internet Protocol
IR	infrared
ISR	intelligence, surveillance, and reconnaissance
JOC	Joint Operations Center
JPEG	Joint Photographic Experts Group
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LRF	laser range finder
MPSS	Maritime Persistent Surveillance System
MPST	Maritime Persistent Surveillance Tower
MSA	maritime situational awareness
MTI	moving target indicator
NAVAIR	Naval Air Systems Command
NEMA	National Electrical Manufacturers Association
ONR-RC	Office of Naval Research Reserve Component
PGSS	Persistent Ground Surveillance System
PGST	Persistent Ground Surveillance Tower
PPS	Portable Power System
REAL	Renewable Area Lighting System

RR/IW	Rapid Reaction/Irregular Warfare
RTAF	Royal Thai Armed Forces
SA	situational awareness
SATCOM	satellite communications
STAESS	Soldier Transportable Alternative Energy Storage System
TCOM	Tethered Communications of Maryland
TEC	Technology Experimentation Center
TTP	tactics, techniques, and procedures
U.S.	United States
USPACOM	United States Pacific Command

MEASUREMENTS

A	Ampere
Ah	Ampere-Hour
C	Celcius
F	Fahrenheit
Ft	Foot
Hz	Hertz
km	kilometer
kW	kilowatt
l	Liter
lb	Pound
m	Meter
VAC	Volt (Alternating Current)
VDC	Volt (Direct Current)
W	Watt

EXECUTIVE SUMMARY

The Crimson Viper Field Experiment is conducted annually between the Royal Thai Ministry of Defence (MOD) Defence Science and Technology Department (DSTD) and US Pacific Command Science and Technology Office (USPACOM J85). Crimson Viper 2014 phase IV was executed by the Technology Experimentation Center (TEC) under the ambit of the Thai-American Consultations (THAI TAC) Joint Statement. The purpose of experimentation in Crimson Viper 2014 (CV14) was to introduce leading edge technologies and proposed Concepts of Operation (CONOP) to relevant training audiences while assessing candidate technologies and providing operational feedback to the science and technology (S&T) community. CV14 consisted of four phases. Additional information on the first three phases of CV14 can be found in Annexes A-C of this report.

CV14 Phase IV field experimentation provided a platform to support collaboration and promote interoperability between Royal Thai Armed Forces and U.S. PACOM via S&T partnership with DSTD, assess candidate technologies and provide assessment feedback to the science and technology community, confirm technology maturity prior to introducing to war-fighters, and provide candidate technologies for longer term Royal Thai Armed Forces (RTARF) assessment.

CV14 Phase IV field experimentation was conducted from September 18-26 at the Royal Thai Army Leisure Center, Petchaburi province, Muang Petchaburi district of Thailand. Nine technologies participated in the field experimentation that included the Soldier Transporatable Alternative Engergy Storage System (STAESS), the Renewable Energy Area Lights (REAL) big and small versions, the Smart Portable Power Solution (PPS), the Emergency "Pop-Up" Phone and Power Network (ePoP), the Smart-Direct Assessment in Real Time (Smart-DART), the Persistent Ground Surveillance Tower (PGST), the SolarTEC Solar Powered Coolers, and the First Response 5000 Freshwater Purifier.

CV14 Phase IV technologies were demonstrated and assessed utilizing humanitarian assistance and disaster relief (HADR) and counter improvised explosive device (C-IED) scenarios. These scenarios were designed to mimic the use of these technologies in real world missions. The majority of technologies were located inside of the RTA Leisure Center. The REAL, STAESS, Smart PPS, Smart-DART, First Response 5000, Portable Thermoelectric Coolers, and the main ePOP node were all located on the south end of the Leisure Center near the HADR HQ. Additional ePOP nodes were dispersed through the camp area and across the street near the Mangrove Visitor Center. The PGST, along with the REAL Small, were located just south of the Leisure Center on a leveled area near multiple intersections.

On September 25 the TEC, USPACOM, and DSTD hosted a S&T DV Day. The purpose of the event was to highlight S&T projects as part of an effort to promote bilateral S&T collaboration between the Royal Thai Armed Forces, the Thai MOD, and U.S. PACOM. The event played a key role in highlighting our joint technology focus areas. . The S&T Distinguished Visitors Day consisted of technology briefs and scenario based technical demonstrations of new and emerging technologies that were currently engaged in CV14 Phase IV.

Overall, CV14 Phase IV was a successful event for technology insertion and partner nation S&T collaboration efforts. The data collected from each of the experimentation events will help shape continued technology development for our warfighters and future PACOM S&T engagement efforts.

INTRODUCTION

Purpose

The purpose of Crimson Viper 2014 (CV14) was to experiment with leading edge technologies and proposed Concepts of Operation (CONOP) in relevant operational conditions to gather operational feedback. Additionally, CV14 Phase IV provided engagement opportunities with the Royal Thai Armed Forces (RTARF) and civilian Science & Technology (S&T) partners. This report covers the Technology Experimentation Center (TEC) activities from September 18-26 2014.

Background

The Crimson Viper Field Experiment is conducted annually between the Royal Thai Ministry of Defence (MOD) Defence Science and Technology Department (DSTD) and US Pacific Command Science and Technology Office (USPACOM J85). Crimson Viper is executed under the of the Thai-American Consultations (TAC) Joint Statement. Crimson Viper was discussed during TAC XVI on 9-11 April 2014 under Working Group IV for “Relationship Building, Coordination and Collaboration at All Levels” under subgroup IV.2 for Science and Technology.

CV14 technology sharing opportunities included briefings and demonstrations by both US and Thai strategic partners. Combined experimentation featured expeditionary construction, Counter-Improvised Explosive Device (C-IED), and maritime domain awareness (MDA). Phase 1 of CV14 on 23 May focused on the demonstration of the Cold Form Steel (CFS) technology in Sattahip, Thailand (Annex A). The US Naval Construction Battalion (Seabees) are developing and validating expeditionary construction techniques using CFS to support humanitarian assistance/disaster relief (HADR) missions. These techniques were demonstrated and assessed during the Cooperation Afloat Readiness and Training (CARAT) exercise. Phase 2 of CV14 on 6, 9-10 June consisted of an Improvised Explosive Device Network Analysis (IEDNA) Seminar (Annex B). The US Naval Postgraduate School (NPS) IEDNA is a software analysis tool that tracks IED related events in space and time to define the IED threat network. The seminar consisted of two parts; participants identifying IED components in the field and inputting the data into the NPS database, and the participants conducting IED network analysis of the data using the NPS Lighthouse program. Phase 3 of CV14 24, 26 June consisted of a demonstration of the Standoff Covert Eye-safe Explosives Detection System (SCEEDS) (Annex C). SCEEDS provides stand-off detection of explosives and explosive residue at ranges up to 200 meters without the need for laser eye protection. The SCEEDS demonstration was sponsored by the US Army Research Development and Engineering Command (RDECOM) Forward Element Command (RFEC) Pacific. Phase IV of CV14 18-26 September, consisted of field experimentation with nine technologies at the Royal Thai Army’s (RTA) Leisure Center at Chao Samran. Office of Naval Research Reserve Component (ONR-RC) and US Army Research and Development Command Reserve Component (RDECOM-RC) SMEs demonstrated and performed limited assessments on each of the nine participating technologies. These technologies included the Persistent Ground Surveillance Tower (PGST), STAESS, PPS, REAL Big, REAL Small, First Response 5000, Smart-DART, Portable Thermoelectric Cooler, and the ePoP.

CV14 Objectives

To promote continued collaboration between Royal Thai MOD and USPACOM the following major objectives were developed for CV14.
Experiment with candidate technologies in a field environment to:

- Support collaboration and promote interoperability between Royal Thai Armed Forces and USPACOM via S&T partnership with DSTD
- Assess candidate technologies and provide assessment feedback to the science and technology community
- Confirm technology maturity prior to introducing to war-fighters
- Provide candidate technologies for longer term assessment

CV14 Phase IV Scenario

A typhoon swept through Southern Thailand, causing major damage to coastal areas, including infrastructure and homes. Thai first responders, police, and military have begun the process of assessing damage and relocating displaced residents. Political rivals in the area have been thwarting assistance efforts by emplacing Improvised Explosive Devices (IED) along main supply routes. The Thai government requested US assistance through the Embassy/Department of State. In turn, the State Department requested Department of Defense (DoD) support for the RTAF to assist with operations in the Chao Samran region, to include transportation and security of supplies and equipment provided by the Thai government and non-governmental organizations; command and control; and provision of clean water for residents and displaced persons. The DoD responding initially with technology equipment already in Thailand for the Crimson Viper Field Experiment. The Crimson Viper response began on 18 September with prepositioned technology equipment starting to arrive on site in Chao Samran, approximately two days after typhoon landfall in the area on 16 September.

Within the context of the overarching scenario of CV14 Phase IV, two mini scenarios were developed to provide a training and demonstration mechanism for the Thai users and Distinguished Visitors (DV) Day visitors. These scenarios were designed to mimic the use of these technologies in real world missions. Below is a summary of the two mini scenarios developed for CV14 Phase IV. Detailed versions of these scenarios can be found in Appendix B Along with checklist developed to help support scenario execution in Appendix C and D.

Mini Scenario 1: HADR Medical Scenario

- <u>Objective</u>: Support disaster response operations
- Determine polluted water source with Smart-DART
- Purify water with First Response powered by Smart PPS
- Illuminate response operations with REAL
- Notify population of relief sites using ePoP and mobile phones
- Distribute water and medicine from relief sites from coolers
- Power technologies with STAESS

Mini Scenario 2: C-IED and Maritime Scenario

- <u>Objective</u>: Detect/identify motorcycles carrying IEDs and/or IED operator
- PGST radar detect/classify/track vehicles, motorcycles, and people
- Unattended ground sensors (UGS) detect/classify vehicles, motorcycles, and people

- PGST GCS/RTOC provide near real-time imagery from tower, ground cameras and smartphone users
- PGST GCS operator and smartphone users identify potential threats

Participants

The following section provides information on the CV14 participants.

USPACOM J85

USPACOM served as the United States' representative for S&T collaboration with DSTD during CV14. USPACOM is one of six geographic Unified Combatant Commands of the United States Armed Forces. Commander, U.S. Pacific Command (CDRUSPACOM) is the senior U.S. military authority in the Pacific Command AOR. CDRUSPACOM reports to the President of the United States through the Secretary of Defense and is supported by four service component commands: U.S. Pacific Fleet, U.S. Pacific Air Forces, U.S. Army Pacific and U.S. Marine Corps Forces, Pacific. These commands are headquartered in Hawaii and have forces stationed and deployed throughout the region.

Technology Experimentation Center (TEC)

During CV14, the TEC served as the PACOM J85 executive agent responsible for coordinating and executing all aspects of CV14 to include logistics, scenario development and assessment of the technologies demonstrated. The TEC representatives also provided SME knowledge during visitor briefs. The TEC is a U.S. Government consortium of technology and operational community subject matter experts working together to enable the warfighter by conducting technology demonstrations, experiments, and assessments in relevant operational venues and environments. For CV14, Naval Air Systems Command and SPAWARS Systems Center provided the subject matter experts to the TEC.

Royal Thai Armed Forces (RTARF)

The RTARF provided the users for the technology demonstrations and assessments. These users worked daily with the participating technologies and provided valuable feedback during the demonstration period. The RTARF's main role is the protection of the sovereignty and territorial integrity of the Kingdom of Thailand. The armed forces are also charged with the defence of the monarchy of Thailand against all threats both foreign and domestic. Apart from these roles, the armed forces also have responsibilities ensuring public order and participating in social development programs by aiding the civilian government. The armed forces are also charged with assisting victims of national disasters and drug control. In recent years the RTARFhave begun increasing its role on the international stage by providing peacekeeping forces to the United Nations

Defence Science and Technology Department (DSTD)

DSTD is a department of the Thai Ministry of Defence that focuses on Science and Technology initiatives. During CV14, DSTD served as the executive agent for S&T collaboration with USPACOM.

Naval Air Systems Command (NAVAIR) Rapid Reaction/Irregular Warfare (RR/IW)

NAVAIR was a U.S. technology provider, deploying the Persistent Ground Surveillance Tower, EO/IR sensors, and common operating picture software. The PGST team provided SME

knowledge during visitor briefs and supported the execution of data collection during CV14 scenarios. NAVAIR's mission is to provide full life-cycle support of naval aviation aircraft, weapons and systems operated by Sailors and Marines. This support includes research, design, development and systems engineering; acquisition; test and evaluation; training facilities and equipment; repair and modification; and in-service engineering and logistics support.

Office of Naval Research (ONR)
ONR sponsored all CV14 Phase 4 technologies except for the PGST. ONR is an executive branch agency within the Department of Defense that coordinates, executes, and promotes the science and technology programs of the U.S. Navy and Marine Corps through schools, universities, government laboratories, and nonprofit and for-profit organizations.

Office of Naval Research Reserve Component (ONR-RC)
The ONR-RC provided personnel to support demonstration and data collection efforts during CV14 Phase IV. ONR-RC provided SME knowledge during demonstration briefings, trained users of each of the participating technologies, and collected feedback from users and distinguished visitors throughout the event.

US Army Research, Development, and Engineering Command-Reserve Component (RDECOM-RC)
The RDECOM-RC provided personnel to support demonstration and data collection efforts during CV14 Phase IV. RDECOM-RC provided SME knowledge during demonstration briefings, trained users of each of the participating technologies, and collected feedback from users and distinguished visitors throughout the event.

Figure 1: CV14 Phase IV US Team Leads

Schedule

The following table provides a brief summary of the CV14 Phase IV schedule of events.

Table 1: CV14 Phase IV Schedule

Date	Event
9/16/14-9/18/14	• ADVON and Main Body arrivals into BKK
9/18/14-9/19/14	• PGST Setup and Testing • Coordinated with US Embassy, DSTD, and Customs for equipment release
9/20/14	• PGST Testing • Received all equipment from customs • CV14 HQ Setup • AAR template/assessment plan review with ONR and RDECOM Personnel
9/21/14	• HADR, Renewable Energy, and ePoP technology Setup and Testing • Preliminary training with Thai national and RTA users • PGST cont. Setup and Testing • Identified new LZ and Port locations for scenarios
9/22/14	• CV14 Phase IV Opening Ceremony • Technology training and assessment using scenarios
9/23/14	• Technology training and assessment using scenarios
9/24/14	• Technology training and assessment using scenarios • Provided technology briefs and demonstrations to visiting flag officers
9/25/14	• DV Day • Packout
9/26/14	• Final AAR • Equipment Shipment
9/27/17-3/28/17	• Main Body Departures

Locations

CV14 Phase IV field experimentation was conducted at the Royal Thai Army Leisure Center, Petchaburi province, Muang Petchaburi district of Thailand. The geographical coordinates of the CV14 HQ and the majority of participating technologies was 12° 59' 26" N, 100° 03' 17" E.

Figure 2: RTA Leisure Center Entrance and Main Building

Figure 3: CV14 Locations Summary

Technology Laydown

The majority of technologies were located inside of the RTA Leisure Center. The REAL, STAESS, Smart PPS, Smart-DART, First Reponse 5000, Portable Thermoelectric Coolers, and the main ePOP node were all located on the south end of the Leisure Center near the HADR HQ. Additional ePOP nodes were dispersed through the camp area and across the street near the Mangrove Visitor Center. The PGST, along with the REAL Small, were located just south of the Leisure Center on a leveled area near multiple intersections.

Figure 4: CV14 HADR equipment left-to-right, REAL Big, First Response 5000, thermoelectric coolers, STAESS, and Smart PPS

Figure 5: PGST Area of Operations

Technology Description

The following sections provide a brief description of each of the nine technologies that participated in CV14. One of these technologies included different versions of a similar technology, i.e. REAL Big and REAL Small.

Soldier Transportable Alternative Energy Storage System (STAESS)

The STAESS consists of efficient foldable photo-voltaic panels and battery packs to provide power. The STAESS is a soldier-portable, rapid-charging photo-voltaic renewable energy system that is modular and expandable to allow for simple set up, transport, and easy operation. The size, efficiency, and power output vary depending on the configuration of modules.

The Renewable Energy Area Lights (REAL) is a solar powered Light Emitting Diode (LED) lighting system that comes in two sizes the REAL Small and the REAL Large. The REAL system is designed to work off of various power sources, including solar. These systems can be used to light a small tented area, or a football field sized Forward Operating Base (FOB). Additionally, the systems include USB ports for charging phones and other auxiliary devices.

Smart Portable Power Solution (PPS)
The Smart PPS is an energy harvesting and energy storage solution. The system utilizes Storm 165 solar modules that are power-dense, fast charging, ruggedized, weather proof, and simple to deploy. The power storage component includes a 4kW 230 VAC 50Hz inverter, charge controller, 2.5kWh LiFe P04 24 VDC 100Ah battery at 80% DOD, ethernet port, and battery management system.

Emerengcy "Pop Up" Phone and Power Network (ePoP)
ePop is a man portable, rugged, all-weather, pop-up emergency network. The system can operate 24/7 off-the-grid using photovoltaics and battery sources. The system consists of a master node and other nodes used to create a wireless dark network. The wireless mesh nodes are self-configuring and self-healing. They are able to operate on various frequencies including 802.11, military, or public safety frequencies. Coverage can reach up to 3-5 football fields per node. They system utilizes an app to allow voice, text, video, and location sharing amongst users.

Smart- Direct Assessment in Real Time (Smart-DART) is a portable molecular diagnostic platform to test for pathogens, with results displayed on a tablet or laptop. The device uses Bluetooth technology for wireless connectivity and shares data via the internet. Smart-DART weighs less than one pound, can operate for multiple hours on one charge and has a footprint of 3" X IV". Smart-DART does not require temperature changes for reactions to occur, which makes it less expensive than currently used equipment.

Persistent Ground Surveillance Tower (*PGST)*

The PGST is a mobile, ground-based, multi-sensor payload platform that supports persistent ground surveillance operations. Originally designed to safeguard Forward Operating Bases (FOB) and borders, the PGST is being adapted other missions including Maritime Domain Awareness (MDA) and C-IED. The MST is a smaller, more affordable, mobile system that provides surveillance flexibility to the user.

The SolarTEC Solar Powered Solid-State Refrigerator

The SolarTEC Solar Powered Solid-State Refrigerator is a solar powered refrigerator with a solid-state DC thermoelectric engine. The system has the simple, rugged design that can provide twice the cooling power of conventional TEC. The system is light weight, easy to setup, with an over 30L internal volume. The electrical battery can be replaced with a thermal battery. The system can run with 1 solar panel, or 2 panels with 140W maximum output can charge the battery fully in ~5 hrs of direct sunlight.

First-Response Freshwater Purifier has Superior Ultra-filtration (UF) membrane capability to remove all microorganisms and virtually all suspended solids and turbidity in one stage. Unique cleaning capability for the UF membrane that does not require power, nor sophisticated instrumentation and control
Capability:
Produces 5000 gallons purified water per day
Easy to transport, set-up and train

Technology Power and Capacity Summary

The table below provides a summary of the power output, production, capacity, and number of systems that participated in the CV14 Phase IV event.

Table 2: TD Technology Power and Capacity Summary

Humanitarian Assistance Disaster Recovery TF EE Demo				
Renewable Energy System	**Max Power Output (W)**	**Max Daytime Production (kWh over a 10 hour period)**	**Max Battery Capacity (kWh)**	**Number of systems**
Renewable Energy Area Lighting (REAL) Small (3,800 lumens)	280	2.8	1.0	1
Renewable Energy Area Lighting (REAL) Big (10,800 lumens)	440	IV.IV	2.IV	1
Smart Portable Power Solution (PPS) (8 PV modules, max 24)	1,000	10	2.IV	1
Soldier Transportable Alternative Energy Storage System (STAESS) (24 PV modules, max 32)	3,000	30	IV.8	1

CV14 PHASE IV INTRODUCTION

CV14 Phase IV was conducted at the RTA Leisure Center, Petchaburi province, Muang Petchaburi district of Thailand and provided an operationally realistic environment for the TEC and DSTD to demonstrate technologies.

During CV14 Phase IV the demonstration team provided training and demonstrations on nine different technologies in the categories of renewable energy, HADR, Comms, and counter IED. Technology SMEs conducted training and collected feedback utilizing operationally realistic scenarios that fit the HADR focus of the CV14 Phase IV event. Additionally, the team provided scenario based demonstrations and technology briefs to visiting distinguished visitors (DV) during DV day.

Distinguished Visitors Day

The CV14 team hosted a S&T DV Day at the RTArmy Leisure Center on 25 September 2014. The purpose of the event was to highlight S&T projects and to promote bilateral S&T collaboration between the Thai MoD, and USPACOM. This event played a key role in highlighting the RTAF and PACOM collaboration on technology experimentation. The S&T Distinguished Visitors Day consisted of technology briefs and scenario based technical demonstrations of new and emerging technologies that were evaluated during CV14 Phase IV.

The following Distinguished Visitors participated in the CV14 Phase IV DV Day:

Thai Representatives:

- LTG Takerngkarn Sri-am-pai, Director-General, Defence Science and Technology Department RADM Sahapong Kruapech, Director of Military Research and Development Centre
- MG Anirush Masaodee, Delegation from Defence Science and Technology Department
- AVM Todsanop Kachacheewa, Delegation from Defence Science and Technology Department
- Gp Capt Amnaj Thongaon, Chief of Staff for Defence Science and Technology Department
- MG Choochad Beaukaow, Director of Army Research and Development Office
- RADM Paitoon Prasonbsin, Director of Navy Research and Development Office
- AVM Shanid Sukwan, Director of Research and Development Centre for Space and Aeronautical Science and Technology, RTAF
- COL Nattapol Boonngam, Delegation from Joint Operation Directorate, Royal THail Armed Force

US Representatives:

- COL Dunlap, Commander, RDECOM Forward Element Command – Pacific
- LtCol Fisher, Deputy USPACOM Deputy Science Advisor
- Mr. Shujie Chang, Director, Technology Experimentation Center (TEC)

Figure 6: DV Day participants are briefed on the CV14 Phase IV scenario and technologies (Left) and Thai and US team members participating in DV Day briefs

Figure 7: Thai users begin equipment setup during DV Day HADR/Med Scenario

Figure 8: Thai users complete equipment setup during DV Day (Left) and Thai users provide DVs with a demonstration of the First Response 5000 (Right)

Figure 9: Maj Christensen provides a brief on the ePoP while Thai users demonstrate system setup and operation (Left) and Thai user process water samples using the Smart-DART during DV Day (Right)

CV14 PHASE IV: DEMONSTRATION AND OBSERVATIONS

The following sections provide an overview of the CV14 Phase IV activities for each of the participating technologies, more detailed technology specifications, and some observations and user feedback collected during the event.

RENEWABLE ENERGY AREA LIGHT SYSTEM (REAL)

The TEC, under the direction of the USPACOM J85, conducted a data collection and evaluation effort of the Renewable Energy Area Light System (REAL) system manufactured by Green Path Technologies, Inc. under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 was conducted at RTA Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Chao Samran Beach Army Camp Thailand.

REAL is a man-portable alternative energy power charging and storage system that provides area lighting via a battery charged by electricity generated from portable, foldable solar panels. REAL comes in two sizes, REAL Big and REAL Small. REAL Big, as tested in CV14, was comprised of three main components: a power control unit with one 100 Ah $LiFePO_4$ battery banks, a tripod with six LED lamps, and four foldable STORM 125 125W solar panels. REAL Small, is a smaller version of REAL Big with two LED lamps, and two foldable Storm 140 140W solar panels.

CV14 Phase IV Demonstration Support

REAL Big provided independent, stand-alone, self-sufficient, easy-to-use reliable source lighting to an area with other experimental systems for approximately 8 hours per day. REAL Big operated alongside other technologies that included the Smart Portable Power System (Smart PPS), Soldier Transportable Alternative Energy System (STAESS), First Response 5000, and thermo-electric coolers, as part of the CV14 HADR scenario. The REAL Small system was deployed to illuminate the PGST site at night. Due to limited personnel for data collection, and the night ops nature of the mission, detailed data and feedback was not collected on the REAL Small system. However, it was observed that the system successfully illumined the PGST site while deployed and provided valuable security/theft deterrent support during CV14 Phase IV.

One Office of Naval Research - Reserve Component (ONR-RC) officer and 11 Royal Thai Armed Forces (RTAF) personnel operated REAL Big at the Royal Thai Army Leisure Center in the HADR exercise scenario headquarters area.

Figure 10: Location of REAL Big co-located with the HADR HQ

The ONR-RC officer trained 11 RTAF personnel to assemble and operate the REAL Big system. The RTAF personnel assembled, operated, and disassembled REAL Big on a daily basis. REAL Big was set-up to illuminate other experimental technologies used as part of the CV14 Phase IV HADR scenario. REAL Big was able to provide illumination thought the day, and well into the evening, after which the batteries would run out of charge. The performance of the REAL Big system was not observed during nighttime hours.

Figure 11: RTAF and ONR-RC Personnel setting up REAL Big

REAL Demonstration Daily Evolutions

The following table is a summary of the daily schedule and evolutions by day followed by the REAL Big team.

Table 3: Daily CV14 Evolutions

Daily Schedule		Evolutions by Day	
Time	**Event**	**Day**	**Theme**
0800-0830	Setup	20 Sep	Set up CV14 headquarters
0830-0845	Morning Meeting	21 Sep	Initial equipment set-up
0900-1145	Operations/Assessment	22 Sep	Demonstration, orientation and training on equipment
1145-1300	Lunch	23 Sep	Practice run through of HADR scenario
1300-1600	Operations/Assessment	24 Sep	Full run through of HADR scenario
1600-1700	Daily Wrap-up (All hands)	25 Sep	Demonstration of technologies to VIP's

REAL Demonstration Participants

The following table provides a summary of the participants that supported the REAL demonstration and evaluation.

Table 4: CV14 REAL Big Participants

Last	First	Rank	Organization	Role
Niyomwan	Boonchana	CDR	Military Research and Development, Science Department, Ministry of Defense	RTAF HADR scenario lead
Unepan	Pitucpong	Lt Col	Army Research and Development Office	RTAF HADR scenario deputy lead
Carrizosa	Santiago	LCDR	ONR-RC	U.S. HADR scenario lead
Ferron	James	LCDR	ONR-RC	U.S. HADR scenario deputy lead
Thonthom	Deacha	Sub Lt	Signal Department	RTAF user
Sasom	Santipong	Sub Lt	Signal Department	RTAF user
Niboonthan	Chalerm	SM1	Signal Department	RTAF user
Tararam	Siri	SM1	Signal Department	RTAF user
Thongkham	Sewee	SM1	Medical Department	RTAF user
Pongsin	Suchin	SM1	Engineering Department	RTAF user
Jitharn	Chan	SM1	Engineering Department	RTAF user
Duran	Francisco	CTR*	NAVMAR Applied Sciences Corp.	U.S. user

Figure 12: REAL Big participants

Technical Specifications
The following section provides more detailed technical specification for the REAL capability. The information provided includes system specifications and benefits.

Table 5: REAL Big System Specifications

Item	Description	Quantity
Solar panels	STORM 125 (125 W)	1
Batteries	24 VDC 100 Ah	1
Lamps	1800 lumen LED lamps	6
Battery type	$LiFePO_4$	N/A
Charge cycles	3000	each
Output receptacles	5 VDC Type: USB	2

Observations and Feedback
REAL Big proved to be easily transported over long distances from Hawaii to Thailand, as well as be easily transported between locations in Thailand using a normal cargo truck that carried other CV14 equipment. REAL Big was manually carried over distance of up to 100 meters within the Royal Thai Army Leisure Center area. REAL Big worked reliably, except on the last day of the exercise, and all REAL Big components operated in an uncovered, outdoor environment.

REAL Big demonstrated that at a portable, solar-powered lighting system could provide lighting to a 100 ft by 50 ft area in an HADR environment. REAL Big operated alongside other technologies that included the Smart Portable Power System (Smart PPS), Soldier Transportable Alternative Energy Storage System (STAESS), First Response 5000, and three thermo-electric coolers, as part of the CV14 HADR scenario.

Objective 1: Assess the effectiveness of the REAL to provide lighting in an HADR scenario. This objective is to determine how REAL Big was able to support the HADR scenario.

Observation 1: On September 23, REAL Big was able to charge from 0% to 100% during daylight hours.
Feedback: REAL Big was set-up in a clearing surrounded by tall trees. This affected the Sun's incidence on the solar panels from sunrise to about 1000 and from 1500 to sunset, but REAL Big was still able to fully charge in a single day.
Recommendation: None.

Observation 2: On September 22, all six REAL Big LED lamps were turned on at 1723L and on the morning of September 23, the lights were off and the battery as found to be at a 0% charge. The time at which the lights turned off is not known.
Feedback: The CV14 participants we at the HQ from 0800 to 1730 and were not present to observe at what point the lights would turn off. The CV14 HADR took place in daylight hours and the actual effectiveness of REAL Big on illuminating the area surrounding the CV14 headquarters during nighttime hours could only be inferred.
Recommendation: None.

Objective 2: Assess the mission impact of the REAL.
This objective is to assess the system's impact on safety, workload, situational awareness, integration into current practices, etc.

Observation 1: How would the REAL Big/Small be integrated into RTA HADR missions? RTAF personnel mentioned that REAL Big could be used to light small areas in disaster areas, specifically in locations where there is a concentration of equipment, personnel or assets.
Feedback: REAL Big can certain be used in HADR situations. However, REAL Big did not have spare parts, instruction, diagrams for use and maintenance. During CV14, the plastic connectors failed during operations and could not be repaired in the field.
Recommendation: Provide diagrams, specifications, and pictorial instructions on the equipment itself. Provide a supply of critical spare parts as any component could conceivably fail in the middle of an HADR mission.

Figure 13: Broken plastic connector (Left) RTAF personnel trouble shooting (Right)

Observation 2: How would the REAL Big/Small support other types of RTA missions? RTAF personnel mentioned that REAL Big would be very useful in field hospitals, field messing facilities, tent areas, in providing emergency lighting within buildings, and lighting key areas for security reasons.

Feedback: Same feedback as previous observation.
Recommendation: Same recommendation as previous observations.

Objective 3: Deployability
This objective is to determine the portability aboard vehicles, the ability to be manually transported, and the ability to withstand rugged, expeditionary, HADR environments.

Observation 1: STAESS, along with other CV14 technologies, was able to be easily transported from Hawaii to Thailand, and then to the Philippines.
Feedback: None.
Recommendation: None.

Observation 2: REAL Big, along with other CV14 technologies, was able to be transported between locations in Thailand by commercial truck.
Feedback: None.
Recommendation: None.

Observation 3: REAL Big was able to be carried by hand over distances up to 100 m by hand.
Feedback: RTAF personnel said on numerous occasions that they, as soldiers, could carry REAL Big and other CV14 components, but that the components were too heavy to be carried easily by Asians in general.
Recommendation: RTAF personnel mentioned that REAL Big should have more carrying handles and should be made smaller if possible.


Figure 14: RTAF personnel carrying REAL Big (Left) Transported by cargo truck (Right)

Objective IV: Usability
This objective is to determine how easy or difficult it is for person to set-up and operate the technology.

Observation 1: Once users can figure out how the various components are connected to each other, and the order of turning-on components is determined, REAL Big can be assembled and able to provide power in about 5 minutes.

Feedback: REAL Big can be set-up very quickly and RTAF personnel were impressed by this capability.
Recommendation: None.

Observation 2: The REAL Big LCD control panel is difficult to understand and cumbersome to use.
Feedback: The LCD control panel buttons and menus are non-intuitive. The attempted use consisted of randomly pushing buttons. Even after several days of using the system, the exact functions of some of the buttons and the interpretation of what was said on some screens was not clear.
Recommendation: Have printed diagram on the case showing the hierarchy of the functions and the button pushing methodology of the LCD control panel. Replace the current panel with one that is more intuitive and easier to use.

Observation 3: Users found it difficult to know how much time a given battery charge would be able to supply a given electrical load. This information is needed when powering critical equipment during nighttime hours or when the solar panels are not available to charge the batteries.
Feedback: Measuring the amperage draw, the DC voltage, and doing a calculation to determine how much time a given battery charge can supply a given load is impractical to do.
Recommendation: The control panel should show:

- In red Light Emitting Diode (LED) numbers, the percentage of battery charge left, on a scale from 0% to 100%, analogous to fuel gauges in cars. 0% would be defined as the state at which battery capacity is no longer available to the user.
- In red LED numbers, the time left to drain the battery based on the instantaneous power draw.
- In red LED numbers, the instantaneous power draw in watts.
- The reason for the red LED's is that LCD displays are difficult to read in direct sunlight and even more difficult to read at high ambient temperatures.

Figure 15: LCD Control Panel (Left) RTAF personnel assembling REAL Big (Right)

Conclusions
The overall objective to test REAL Big in an expeditionary environment, within a plausible scenario, while demonstrating interoperability with RTAF, was a success.

REAL Big proved that it was deployable, easy to set-up and easy to operate. REAL Big was set-up in an area where it could easily illuminate other equipment critical to the CV14 Phase IV HADR scenario that included Smart PPS, STAESS, First Response 5000 and three thermo-electric coolers. REAL was able to fully charge its batteries prior to mid-afternoon each day and provide electricity even when sunlight was not available. RTAF users not familiar with REAL Big were able to be trained and subsequently became highly proficient at operating REAL Big. RTAF users were able to set-up operate and tear-down the equipment each day over several days. The training provided to RTAF personnel was limited to the use and operation of REAL Big and did not include technically oriented maintenance or troubleshooting training as adequate documentation for this type of training was missing. Also spare parts were not available. REAL Big would greatly benefit from some easily implemented minor design improvements including the use of military-grade electrical connectors, a more-user friendly control panel, a listing of the technical specification printed on or attached to the REAL Big case, graphics-only instructions printed on or attached to the REAL Big case, and standard supply of critical spare parts.

REAL Big performed very well at CV14 Phase IV and would be extremely useful in actual HADR situations as well as in a wide variety of actual expeditionary conditions.

Smart Portable Power System (PPS)

The Technology Experimentation Center (TEC), under the direction of the Pacific Command's Science Advisor, conducted a data collection and evaluation effort of the Smart Portable Power System (Smart PPS) manufactured by Samuel Engineering, Inc. under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Thailand.

Smart PPS is a man-portable alternative energy power charging and storage system that provides an uninterrupted source of electricity derived from portable, foldable solar panels or from a portable gasoline generator. Smart PPS, as tested in CV14 Phase IV, was comprised of four main components: an inverter/power control unit with an integrated 100 Ah battery bank, and 10 foldable STORM 125 125W solar panels.

CV14 Demonstration Support
Smart PPS provided an independent, stand-alone, self-sufficient, easy-to-use reliable power source for the Joint Operations Center (JOC) and key experimental technologies approximately 8-18 hours per day. Smart PPS operated alongside other technologies that included the Soldier Transportable Alternative Energy Storage System (STAESS), Renewable Energy Area Lighting (REAL), and First Response 5000 as part of the HADR scenario.

Smart PPS powered the following devices for approximately 8-18 hours per day:

- Four computers in the Joint Operations Center (JOC)

- Printer
- A video monitor showing the Persistent Ground Surveillance Tower (PGST) output in the JOC
- Four tablet computers and the disease detection modules of Smart-Direct Assessment in Real Time (Smart DART)
- Smart phones of the Emergency Pop-Up Phone and Power Network (ePOP)
- Two of three thermo-electric coolers
- Two fluorescent lamps
- Portable fan

Figure 16: Thermo-electric coolers, fan, and JOC powered by Smart PPS

One Office of Naval Research - Reserve Component (ONR-RC) officer and 11 Royal Thai Armed Forces (RTAF) personnel operated Smart PPS at the Royal Thai Army Leisure Center in the HADR exercise scenario headquarters area.

Figure 17: Location of Smart PPS co-located with the HADR HQ

The ONR-RC officer trained 11 RTAF personnel to assemble and operate Smart PPS. The RTAF personnel assembled, operated, and disassembled Smart PPS on a daily basis. Smart PPS

powered four computers in the Joint Operations Center (JOC), a video monitor showing the Persistent Ground Surveillance Tower (PGST) output, both the tablet computers and the disease detection modules of Smart-Direct Assessment in Real Time (Smart DART), the smart phones of the Emergency Pop-Up Phone and Power Network (ePOP), two of three thermo-electric coolers, two fluorescent lamps, and a portable fan. Smart PPS was able to provide reliably power thought the day, and well into the evening, after which the batteries would run out of charge.

Smart PPS Demonstration Daily Schedule and Evolutions

The following table is a summary of the daily schedule and evolutions by day followed by the Smart PPS team.

Table 6: Daily Schedule and Evolutions

Daily Schedule			Evolutions by Day	
.	Event		Day	Theme
0800-0830	Setup		20 Sep	Set up CV14 headquarters
0830-0845	Morning Meeting		21 Sep	Initial equipment set-up
0900-1145	Operations/Assessment		22 Sep	Demonstration, orientation and training on equipment
1145-1300	Lunch		23 Sep	Practice run through of HADR scenario
1300-1600	Operations/Assessment		24 Sep	Full run through of HADR scenario
1600-1700	Daily Wrap-up (All hands)		25 Sep	Demonstration of technologies to VIP's

Smart PPS Demonstration Participants

The following table provides a summary of the participants that supported the Smart PPS demonstration and evaluation.

Table 7: CV14 Smart PPS Participants

Last	First	Rank	Organization	Role
Niyomwan	Boonchana	CDR	Military Research and Development, Science Department, Ministry of Defense	RTAF HADR scenario lead
Unepan	Pitucpong	Lt Col	Army Research and Development Office	RTAF HADR scenario deputy lead
Carrizosa	Santiago	LCDR	ONR-RC	U.S. HADR scenario lead
Ferron	James	LCDR	ONR-RC	U.S. HADR scenario deputy lead
Thonthom	Deacha	Sub Lt	Signal Department	RTAF user
Sasom	Santipong	Sub Lt	Signal Department	RTAF user
Niboonthan	Chalerm	SM1	Signal Department	RTAF user
Tararam	Siri	SM1	Signal Department	RTAF user
Thongkham	Sewee	SM1	Medical Department	RTAF user
Pongsin	Suchin	SM1	Engineering Department	RTAF user
Jitharn	Chan	SM1	Engineering Department	RTAF user
Duran	Francisco	CTR	NAVMAR Applied Sciences Corp.	U.S. user

Figure 18: Smart PPS CV14 participants

Technical Specifications

The following section provides more detailed technical specification for the Smart PPS capability. The information provided includes system specifications and benefits.

Table 8: Smart PPS System Specifications

Item	Description	Quantity
Solar panels	STORM 125 (125 W)	10
Batteries	24 VDC 100 Ah	1
Battery type	$LiFePO_4$	N/A
Charge cycles	3000	each
Inverter	4000 W	1
Output Receptacles	240 VAC UK plug w/ GFCI	1
Input receptacles	120 VAC NEMA L6-30 male plug	1
	PV Solar Panel Inputs	2
Charger controller	2500 kWh	1
Gasoline generator	Honda EU3000iS 120V, 3kW, 25A	1

Observations and Feedback

Smart PPS proved to be easily transported over long distances from Hawaii to Thailand as well as be easily transported between locations in Thailand using a normal cargo truck that carried other CV14 equipment. Smart PPS was manually carried over distance of up to 100 meters within the Royal Thai Army Leisure Center area. Smart PPS worked reliably and all Smart PPS components, except the generator, were able to operate in an uncovered, outdoor environment. The main reason the generator could not operate was due to the exposed electronics module that was supposed to enable the automatic operation of the generator when coupled to Smart PPS.

Objective 1: Deployability
This objective is to determine the portability aboard vehicles, the ability to be manually transported, and the ability to withstand rugged, expeditionary, HADR environments.

Observation 1: Smart PPS, along with other CV14 technologies, was able to be easily transported from Hawaii to Thailand, and then to the Philippines.
Feedback: None.
Recommendation: None.

Observation 2: STAESS, along with other CV14 technologies, was able to be transported between locations in Thailand by commercial truck.
Feedback: None.
Recommendation: None.

Figure 19: Equipment Offload (Left) and Smart PPS generator in a passenger van (Right)

Observation 3: STAESS was able to be carried by hand over distances up to 100 m by hand.
Feedback: RTAF personnel said on numerous occasions that they, as soldiers, could carry Smart PPS and other CV14 components, but that the components were too heavy to be carried easily by Asians in general.
Recommendation: Make Smart PPS components lighter.

Figure 20: Thais carrying Smart PPS generator (Left) and inverter/battery module (Center) and rolling inverter/battery module on non-paved terrain with ease (Right)

Observation 4: Large wheels on both the Smart PPS inverter/battery module and the generator made transport over rough terrain easy by rolling on the ground.
Feedback: None.
Recommendation: Use cases with larger wheels that can be rolled over non-paved terrain.

Objective 2: Usability

This objective is to determine how easy or difficult it is for person to set-up and operate the technology.

Observation 1: The lack of any written instruction makes initial installation more difficult than it ought to be and takes somewhere between one to two hours and involves connecting the components intuitively.
Feedback: While Smart PPS is by definition a simple system with a small number of components, certain portions of the installation and set-up involved guess-work and it was difficult to know what the correct order of connecting the components together was.
Recommendation: Smart PPS should have printed diagrams, or a series of diagrams, preferably with no works, showing the overall system schematic, and the correct order of performing key set-up tasks.

Figure 21: Schematics or diagrams can be printed the inside lid of the Smart PPS module

Observation 2: Once users can figure out how the various components are connected to each other, and the order of turning-on components is determined, Smart PPS can be assembled and able to provide power in about 5 minutes.
Feedback: Smart PPS can be set-up very quickly and RTAF personnel were impressed by this capability.
Recommendation: None.

Figure 22: RTAF assembling Smart PPS (Left) and Smart PPS solar panels (Right)

Observation 3: The Smart PPS LCD control panel is difficult to understand and cumbersome to use.
Feedback: The LCD control panel buttons and menus are non-intuitive. The attempted use consisted of randomly pushing buttons. Even after several days of using the system, the exact functions of some of the buttons and the interpretation of what was said on some screens was not clear.
Recommendation: Have printed diagram on the case showing the hierarchy of the functions and the button pushing methodology of the LCD control panel. Replace the current panel with one that is more intuitive and easier to use.

Figure 23: Smart PPS LCD Control Panel

Observation 4: Users found it difficult to know how much time a given battery charge would be able to supply a given electrical load. This information is needed when powering critical equipment during nighttime hours or when the solar panels are not available to charge the batteries.
Feedback: Measuring the amperage draw, the AC voltage, and doing a calculation to determine how much time a given battery charge can supply a given load is impractical to do.
Recommendation: The control panel should show:

- In red Light Emitting Diode (LED) numbers, the percentage of battery charge left, on a scale from 0% to 100%, analogous to fuel gauges in cars. 0% would be defined as the state at which battery capacity is no longer available to the user.
- In red LED numbers, the time left to drain the battery based on the instantaneous power draw.
- In red LED numbers, the instantaneous power draw in watts.
- The reason for the red LED's is that LCD displays are difficult to read in direct sunlight and even more difficult to read at high ambient temperatures.

Observation 5: Smart PPS only has 230 VAC output which was incompatible with the 120 VAC pump for the First Response 5000 water filtration system that the Smart PPS was originally intended to power.
Feedback: None.
Recommendation: Smart PPS should have both 120 VAC and 240 VAC output receptacles as devices of each voltage class will likely have to be powered in an HADR situation. The both the Smart PPS output receptacles should be of the multi-standard type that accepts British, European, NEMA American and Australian plugs.

While the use of plug adaptors may seem like a more straight forward solution, finding the correct adaptors in remote, rural overseas locations is sometimes difficult or impossible, and the lack of spare parts, as seen with most equipment involved in these types of exercises, means that the correct plug adaptors will likely not be present when needed most.


Figure 24: Smart PPS with only 230 (Left) and an Example of a multi-standard electrical receptacle with GCFI (Right)

Observation 6: The electronic module for automatic operation of the generator is exposed to the elements.
Feedback: The electronics module is too exposed to the elements and the generator cannot be left outside uncovered and unattended.
Recommendation: Package the electronics module is a weather-resistant enclosure.

Observation 7: The electronic module for automatic operation of the generator did not work.
Feedback: When the Smart PPS battery charge dropped below 20%, the generator did not engage.
Recommendation: Provide instructions on the proper use of the automatic operations feature of the generator.

Figure 25: Vulnerable Module (Left) and Inverter/battery/generator setup (Right)

Objective 3: Power Production
This objective is to determine if Smart PPS met the energy requirements of the mission.

Observation 1: Smart PPS was able to reliably meet the power demands placed on it during CV14.
Feedback: Power was extremely reliable from set-up in the morning to breakdown between 1600 and 1700 each day. The one instance in which Smart PPS was left to power First Response 5000 overnight resulted in the batteries being fully drained at some point between the times of 1700 and 0800.

Smart PPS successfully powered the following devices:

- Four computers of the Joint Operations Center (JOC)
- Printer
- A video monitor showing the Persistent Ground Surveillance Tower (PGST) output in the JOC
- Four tablet computers and the disease detection modules of Smart-Direct Assessment in Real Time (Smart DART)
- Smart phones of the Emergency Pop-Up Phone and Power Network (ePOP)
- Two of three thermo-electric coolers
- Two fluorescent lamps
- Portable fan

Recommendation: None.

Observation 2: The location of the Smart PPS was not optimal for solar panel charging.
Feedback: Smart PPS was set-up in a clearing surrounded by tall trees. This affected the Sun's incidence on the solar panels from sunrise to about 1000 and from 1500 to sunset, thus limiting the full potential for daily power production.
Recommendation: Proper planning and thoughtful selection should determine where Smart PPS and other solar-powered technologies should be placed to maximize solar incidence.
Observation 3: On September 24, Smart PPS had a 53% charge at 1315 L. With the batteries providing 14 A at 26.5 VDC Smart PPS had a 26% charge at 1444L later that same day.
Feedback: None.
Recommendation: None.

Observation 4: On September 23, the generator, operated manually, was able to charge the 100 Ah battery back from 67% charge to 100% charge in approximately 90 minutes.
Feedback: None.
Recommendation: None.

Objective 4: Power Storage
This objective is to determine how much power the equipment can store.

Observation 1: Smart PPS was able to run off of batteries alone.
Feedback: On multiple occasions, the solar panels were disconnected from the modules and STAESS was able to run the equipment without issue.
Recommendation: None.

Observation 2: The 100 Ah battery bank was able to be charged from 0% to 100%
Feedback: The battery bank was able to be charged from both the generator, when operated manually, and by the solar panels.
Recommendation: None.

Observation 3: When STAESS was activated on the first day, both 100 Ah battery packs were at a 100% state of charge, out of the box.
Feedback: This demonstrates that the batteries can maintain a full charge for more than several days.
Recommendation: None.

Objective 5: Trainability
This objective is to determine if a non-English-speaking able-person can be taught to reliably set-up, operate and maintain the equipment.

Observation 1: U.S. personnel were able to train RTAF personnel over a two day period to reliably operate Smart PPS.

Feedback: RTAF personnel were all technically or scientifically oriented and were able to understand English to varying degrees. Training was conducted in English but the method of instruction that was most successful was by physically demonstrating the set-up, operation and tear down of the equipment, and then asking the RTAF personnel to repeat the actions. RTAF personnel showed great proficiency at operating Smart PPS.
Recommendation: None.
Observation 2: The lack of formal documentation limited the training that could be provided.
Feedback: Smart PPS did not include any maintenance, troubleshooting, technical schematics, or technical specifications. Thus, the training provided to RTAF did not cover these subjects, even though RTAF personnel specifically asked for this type of training.
Recommendation: Provide maintenance, troubleshooting, technical schematics, and technical specifications in heavy-duty laminated form, physically attached to the Smart PPS case, either by directly with rivets or indirectly by a wire rope lanyard.

Objective 6: Maintainability
This objective is to characterize the amount of resources are necessary to maintain the equipment in proper working order.

Observation 1: Smart PPS did not come with any schematics or technical manuals necessary to maintain or repair the unit nor did it come with a supply of spare parts.
Feedback: Lack of specific guidance would have meant that little or no maintenance could have been done on Smart PPS if it was to be used for extended periods. Also, if any repairs or maintenance had been necessary by the RTAF users, they would have had to use improvised methods and improvised spare parts to perform those functions.
Recommendation: NAVAIR should procure and provided users with a supply of spare parts recommended by the manufacturer as well as technical schematics and diagrams.

Objective 7: Mission Impact
This objective is to determine if the equipment was a mission enabler or a mission hindrance.

Observation 1: Smart PPS was not able to power the First Response 5000 system as the pump required 120 VAC electrical power which Smart PPS was not able to provide. Smart PPS was able to successfully power the following devices in the CV14 HADR scenario.

- Four computers of the Joint Operations Center (JOC)
- Printer
- A video monitor showing the Persistent Ground Surveillance Tower (PGST) output in the JOC
- Four tablet computers and the disease detection modules of Smart-Direct Assessment in Real Time (Smart DART)
- Smart phones of the Emergency Pop-Up Phone and Power Network (ePOP)
- Two of three thermo-electric coolers
- Two fluorescent lamps
- Portable fan

Feedback: None.
Recommendation: Smart PPS should be able to provide both 240 VAC and 120 VAC electrical power.

Observation 2: STAESS was able to power a thermo-electric cooler reliably and easily, thereby providing a place to store simulated medicines for the CV14 HADR scenario.
Feedback: STAESS was able to easily provide power to one thermo-electric cooler during CV14.
Recommendation: None.

Figure 26: CV14 personnel working on JOC computers powered by Smart PPS (Left) and RTAF personnel handling simulated medicines stored in a thermo-electric cooler powered by Smart PPS (Right)

Conclusions
The overall objective to test the Smart PPS in an expeditionary environment, within a plausible scenario, while demonstrating the Smart PPS interoperability with RTAF, was a success.

The Smart PPS proved that it was deployable, easy to set-up and easy to operate. Smart PPS successfully powered other CV14 hardware that included four computers of the Joint Operations Center (JOC), a printer, video monitor showing PGST output in the JOC, four tablet computers and the disease detection modules of Smart-Direct Assessment in Real Time (Smart DART), the smart phones of the Emergency Pop-Up Phone and Power Network (ePOP), two thermo-electric coolers, two fluorescent lamps, and one portable fan. Smart PPS was able to fully charge its batteries prior to noon each day and provide electricity even when sunlight was not available. RTAF users not familiar with Smart PPS were able to be trained and subsequently became highly proficient at operating Smart PPS. RTAF users were able to set-up, operate, and tear-down the equipment each day over several days. The training provided to RTAF personnel was limited to the use and operation of the Smart PPS and did not include technically oriented maintenance or troubleshooting training as adequate documentation for this type of training was missing. Also spare parts were not available. The electrical outlet was for 240 VAC and could not power 120 VAC equipment. The Smart PPS would greatly benefit from a more-user friendly control panel, a listing of the technical specification printed on or attached to the Smart PPS case, and graphics-only instructions printed on or attached to the Smart PPS case.

Smart PPS performed very well at CV14 and would be extremely useful in actual HADR situations as well as in a wide variety of actual expeditionary conditions.

Soldier Transportable Alternative Energy Storage System (STAESS)

The Technology Experimentation Center (TEC), under the direction of the Pacific Command's Science Advisor, conducted a data collection and evaluation effort of the Soldier Transportable Alternative Energy Storage System (STAESS) manufactured by Green Path Technologies, Inc. under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14

Phase IV was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Thailand.

STAESS is a man-portable alternative energy power charging and storage system that provides an uninterrupted source of electricity derived from portable, foldable solar panels. STAESS, as tested in CV14 Phase IV, was comprised of four main components: an inverter/power control unit, two 100 Ah battery banks, three power conditioners, and 14 foldable STORM 125 125W solar panels.

CV14 Demonstration Support

STAESS provided an independent, stand-alone, self-sufficient, easy-to-use reliable source of electricity to a water filtration system, First Response 5000, and an experimental thermo-electric cooler, for approximately 8-18 hours per day. STAESS operated alongside other technologies that included the Smart Portable Power System (PPS), Renewable Energy Area Lighting (REAL) system, First Response 5000, Smart DART, and ePOP as part of the HADR scenario.

Figure 27: STAESS modules with solar panels (Left) and Connected to a thermo-electric cooler (Right)

Figure 28: STAESS powering the First Response 5000 pump (Left) and STAESS charging a cell phone

One Office of Naval Research - Reserve Component (ONR-RC) officer and 11 Royal Thai Armed Forces (RTAF) personnel operated STAESS at the Royal Thai Army Leisure Center in the HADR exercise scenario headquarters area.

Figure 29: Location of STAESS co-located with the HADR HQ

The ONR-RC officer trained 11 RTAF personnel to assemble and operate STAESS. The RTAF personnel assembled, operated, and disassembled STAESS on a daily basis. STAESS powered a water filtration technology called First Response and an experimental thermo-electric cooler. STAESS was able to provide reliably power thought the day, and well into the evening, after which the batteries would run out of charge.

STAESS Demonstration Daily Schedule and Evolutions

The following table is a summary of the daily schedule and evolutions by day followed by the STAESS team.

Table 9: Daily Schedule and Evolutions

Daily Schedule			Evolutions by Day	
Time	**Event**		**Day**	**Theme**
0800-0830	Setup		20 Sep	Set up CV14 headquarters
0830-0845	Morning Meeting		21 Sep	Initial equipment set-up
0900-1145	Operations/Assessment		22 Sep	Demonstration, orientation and training on equipment
1145-1300	Lunch		23 Sep	Practice run through of HADR scenario
1300-1600	Operations/Assessment		24 Sep	Full run through of HADR scenario
1600-1700	Daily Wrap-up (All hands)		25 Sep	Demonstration of technologies to VIP’s

STAESS Demonstration and Assessment Participants
The following table provides a summary of the participants that supported the STAESS demonstration and evaluation.

Table 10: CV14 STAESS Participants

Last	First	Rank	Organization	Role
Niyomwan	Boonchana	CDR	Military Research and Development, Science Department, Ministry of Defense	RTAF HADR scenario lead
Unepan	Pitucpong	Lt Col	Army Research and Development Office	RTAF HADR scenario deputy lead
Carrizosa	Santiago	LCDR	ONR-RC	U.S. HADR scenario lead
Ferron	James	LCDR	ONR-RC	U.S. HADR scenario deputy lead
Thonthom	Deacha	Sub Lt	Signal Department	RTAF user
Sasom	Santipong	Sub Lt	Signal Department	RTAF user
Niboonthan	Chalerm	SM1	Signal Department	RTAF user
Tararam	Siri	SM1	Signal Department	RTAF user
Thongkham	Sewee	SM1	Medical Department	RTAF user
Pongsin	Suchin	SM1	Engineering Department	RTAF user
Jitharn	Chan	SM1	Engineering Department	RTAF user
Duran	Francisco	CTR*	NAVMAR Applied Sciences Corp.	U.S. user

Figure 30: STAESS CV14 participants

Technical Specifications
The following section provides more detailed technical specification for the STAESS capability. The information provided includes system specifications and benefits.

Table 11: STAESS System Specifications

Item	Description	Quantity
Solar panels	STORM 125 (125 W)	24
Batteries	24 VDC 100 Ah	2
Battery type	$LiFePO_4$	N/A
Charge cycles	3000	each
Inverter	4000 W	1
Output receptacles	120 VAC NEMA 5-20RA w/ GFCI	2
	240 VAC NEMA L6-30	1
	24 VDC Type – Twist lock	2
	12 VDC Type: cigarette lighter	1
	5 VDC Type: USB	2
Input receptacles	120 VAC NEMA 5-20P male plug	1
Charger controller	TriStar MPPT 60 A	3

Observations and Feedback

STAESS was easily transported over long distances from Hawaii to Thailand as well as be easily transported between locations in Thailand using a normal cargo truck that carried other CV14 Phase 4 equipment. STAESS was manually carried over distance of up to 100 meters within the Royal Thai Army Leisure Center area. STAESS worked reliably and all STAESS components, except for the main inverter/control unit, were able to operate in an uncovered, outdoor environment.

Objective 1: Deployability

This objective is to determine the portability aboard vehicles, the ability to be manually transported, and the ability to withstand rugged, expeditionary, HADR environments.

Observation 1: STAESS, along with other CV14 technologies, was able to be easily transported from Hawaii to Thailand, and then to the Philippines.
Feedback: None.
Recommendation: None.

Observation 2: STAESS, along with other CV14 technologies, was able to be transported between locations in Thailand by commercial truck.
Feedback: None.
Recommendation: None.

Observation 3: STAESS was able to be carried by hand over distances up to 100 m by hand.
Feedback: RTAF personnel said on numerous occasions that they, as soldiers, could carry STAESS and other CV14 components, but that the components were too heavy to be carried easily by Asians in general.
Recommendation: RTAF personnel mentioned that STAESS should have more carrying handles and should be made smaller if possible.

Observation 4: STAESS is difficult to transport over rough terrain by rolling on the ground.
Feedback: None.

Recommendation: Use cases with larger wheels that can be rolled over non-paved terrain.

Figure 31: CV14 Equipment Offload (Left) and RTAF personnel carrying a STAESS battery module (Center) and RTAF personnel attempting to roll a STAESS component on non-paved terrain with much difficulty (Right)

Objective 2: Usability
This objective is to determine how easy or difficult it is for person to set-up and operate the technology.

Observation 1: The lack of any written instruction makes initial installation more difficult than it ought to be and takes somewhere between one to two hours and involves connecting the components intuitively.
Feedback: While STAESS is by definition a simple system with a small number of components, certain portions of the installation and set-up involved guess-work and it was difficult to know what the correct order of connecting the components together was.
Recommendation: STAESS should have printed diagrams, or a series of diagrams, preferably with no works, showing the overall system schematic, and the correct order of performing key set-up tasks.

Observation 2: Once users can figure out how the various components are connected to each other, and the order of turning-on components is determined, STAESS can be assembled and able to provide power in about 10 minutes.
Feedback: STAESS can be set-up very quickly and RTAF personnel were impressed by this capability.
Recommendation: None.

Figure 32: RTAF personnel assembling STAESS modules (Left) and RTAF personnel assembling STAESS solar panels (Right)

Observation 3: The STAESS LCD control panel is difficult to understand and cumbersome to use.
Feedback: The LCD control panel buttons and menus are non-intuitive. The attempted use consisted of randomly pushing buttons. Even after several days of using the system, the exact functions of some of the buttons and the interpretation of what was said on some screens was not clear.
Recommendation: Have printed diagram on the case showing the hierarchy of the functions and the button pushing methodology of the LCD control panel. Replace the current panel with one that is more intuitive and easier to use.

Figure 33: STAESS LCD Control Panel

Observation 4: Users found it difficult to know how much time a given battery charge would be able to supply a given electrical load. This information is needed when powering critical equipment during nighttime hours or when the solar panels are not available to charge the batteries.
Feedback: Measuring the amperage draw, the AC voltage, and doing a calculation to determine how much time a given battery charge can supply a given load is impractical to do.

Recommendation: The control panel should show:

- In red Light Emitting Diode (LED) numbers, the percentage of battery charge left, on a scale from 0% to 100%, analogous to fuel gauges in cars. 0% would be defined as the state at which battery capacity is no longer available to the user.
- In red LED numbers, the time left to drain the battery based on the instantaneous power draw.
- In red LED numbers, the instantaneous power draw in watts.
- The reason for the red LED's is that LCD displays are difficult to read in direct sunlight and even more difficult to read at high ambient temperatures.

Observation 5: STAESS uses only North American National Electrical Manufacturers Association (NEMA) electrical receptacles, some of which are specialty receptacles that may have limited compatibility in countries in the Asia-Pacific region or other regions around the world.
Feedback: STAESS, at CV14, could not power 240VAC items because an adaptor for the 240VAC receptacle was not available. Thai single-phase voltage is 240VAC.
Recommendation: The both the STAESS 120VAC and the 240VAC receptacles should be of the multi-standard type that accepts British, European, NEMA American and Australian plugs.

While the use of plug adaptors may seem like a more straight forward solution, finding the correct adaptors in remote, rural overseas locations is sometimes difficult or impossible, and the lack of spare parts, as seen with most equipment involved in these types of exercises, means that the correct plug adaptors will likely not be present when needed most.

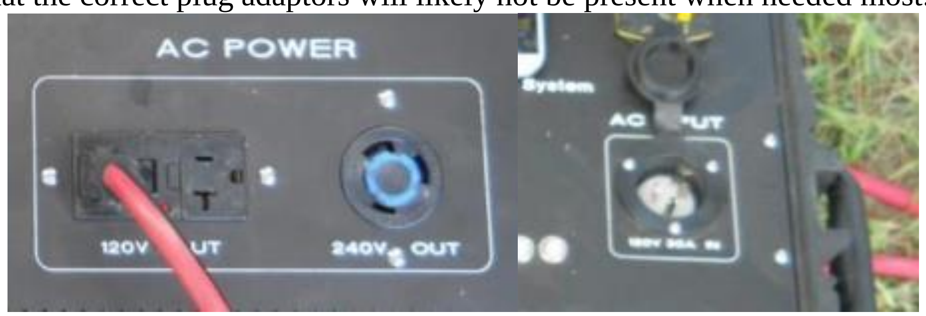

Figure 34: North American NEMA-type electrical receptacles on STAESS (left-to-right) 120VAC NEMA 5-20RA w/ GFCI, 240VAC NEMA L6-30, 120VAC NEMA 5-20P

Figure 35: Example of a multi-standard electrical receptacle with GCFI

Observation 6: The lid of the inverter cannot be closed when electrical cords are plugged in.
Feedback: The fact that the lid cannot be closed when a chord is plugged in means that the STAESS inverter unit must covered by at least a tarp when not directly supervised. It also means that when the lid is partially closed, the lid will tend to pinch the electrical cords.
Recommendation: Place waterproof, covered receptacles on the outside of the STAESS case. STAESS, should in practice, be placed underneath some sort of protective cover whenever practical.

Figure 36: Battery banks, charge controller modules, inverter with cases open

Observation 7: The USB receptacles did not work.
Feedback: The dedicated USB receptacles did not work when attempting to charge a cell phone. A cigarette-lighter type USB adaptor had to be used in the 12VDC cigarette lighter receptacle to charge the cell phone.
Recommendation: Make USB chargers operational.

Figure 37: USB chargers did not work. A USB-cigarette adaptor on the 12VDC receptacle to had to be used to charge cell phone

Objective 3: Power Production
This objective is to determine if STAESS met the energy requirements of the mission.

Observation 1: STAESS was able to reliably meet the power demands placed on it during CV14.
Feedback: STAESS successfully powered the First Response 5000 system, one thermo-electric cooler, and one cell phone. Power was extremely reliable from set-up in the morning to breakdown between 1600 and 1700 each day. The one instance in which STAESS was left to power First Response 5000 overnight resulted in the batteries being fully drained at some point between the times of 1700 and 0800.
Recommendation: None.

Observation 2: The location of the STAESS was not optimal for solar panel charging.
Feedback: STAESS was set-up in a clearing surrounded by tall trees. This affected the Sun's incidence on the solar panels from sunrise to about 1000 and from 1500 to sunset, thus limiting the full potential for daily power production.
Recommendation: Proper planning and thoughtful selection should determine where STAESS and other solar-powered technologies should be placed to maximize solar incidence.

Objective 4: Power Storage
This objective is to determine how much power the equipment can store.

Observation 1: STAESS was able to run off of batteries alone.
Feedback: On multiple occasions, the solar panels were disconnected from the modules and STAESS was able to run the equipment without issue.
Recommendation: None.

Observation 2: Both 100 Ah battery modules were able to be charged from 0% to 100%
Feedback: none.
Recommendation: None.

Observation 3: STAESS solar panels were able to charge one of the two 100 Ah batteries from 0% to 50% from 0712L to 0911L on 23 September. The other battery was intentionally disconnected.
Feedback: High cirrus clouds re-directed significant amounts of sunlight in the morning over the surrounding trees. This enabled rapid charging of the batteries and operations with STAESS.
Recommendation: None.

Observation 4: When Smart PPS was activated on the first day, the 100 Ah battery bank was at a 100% state of charge.
Feedback: This demonstrates that the batteries can maintain a full charge for more than several days.
Recommendation: None.

Objective 5: Trainability
This objective is to determine if a non-English-speaking able-person can be taught to reliably set-up, operate and maintain the equipment.

Observation 1: U.S. personnel were able to train RTAF personnel over a two day period to reliably operate STAESS.
Feedback: RTAF personnel were all technically or scientifically oriented and were able to understand English to varying degrees. Training was conducted in English but the method of instruction that was most successful was by physically demonstrating the set-up, operation and tear down of the equipment, and then asking the RTAF personnel to repeat the actions. RTAF personnel showed great proficiency at operating STAESS.
Recommendation: None.

Observation 2: The lack of formal documentation limited the training that could be provided.
Feedback: STAESS did not include any maintenance, troubleshooting, technical schematics, or technical specifications. Thus, the training provided to RTAF did not cover these subjects, even though RTAF personnel specifically asked for this type of training.
Recommendation: Provide maintenance, troubleshooting, technical schematics, and technical specifications in heavy-duty laminated form, physically attached to the STAESS case, either by directly with rivets or indirectly by a wire rope lanyard.

Objective 6: Maintainability
This objective is to characterize the amount of resources are necessary to maintain the equipment in proper working order.

Observation 1: STAESS did not come with any schematics or technical manuals necessary to maintain or repair the unit nor did it come with a supply of spare parts.
Feedback: Lack of specific guidance would have meant that little or no maintenance could have been done on STAESS if it was to be used for extended periods. Also, if any repairs or maintenance had been necessary by the RTAF users, they would have had to use improvised methods and improvised spare parts to perform those functions.
Recommendation: NAVAIR should procure and provided users with a supply of spare parts recommended by the manufacturer as well as technical schematics and diagrams.

Objective 7: Mission Impact
This objective is to determine if the equipment was a mission enabler or a mission hindrance.

Observation 1: STAESS was able to power the First Response 5000 water filtration system reliably and easily, thereby providing a regular supply of filtered water for the CV14 HADR scenario.
Feedback:

- Both STAESS and First Response 5000 were set-up and disassembled four times during CV14. The average set-up time was 30 minutes from boxed, packed components to a fully powered First Response 5000 system producing filtered, chlorinated water at a rate of approximately three (3) gallons per minute.
- The pump on the First Response 5000 operated on 120VAC electricity. Had the pump operated on 240VAC electricity, STAESS would not have been able to provide

power due to incompatible receptacles and plugs. NAVMAR Applied Sciences Corporation supply personnel attempted to find compatible plug adaptors in the local economy but did not have success.

Recommendation: STAESS should have receptacles that are compatible with the plugs found in the majority of foreign locations where it might be expected to operate.

Figure 38: RTAF personnel simulating the distribution of filtered, chlorinated water produced by a STAESS-powered First Response 5000 system to the local population

Observation 2: STAESS was able to power a thermo-electric cooler reliably and easily, thereby providing a place to store simulated medicines for the CV14 HADR scenario.

Feedback: STAESS was able to easily provide power to one thermo-electric cooler during CV14.

Recommendation: None.

Observation 3: STAESS was able to power a cell phone that provided critical communications capabilities during CV14.

Feedback: The USB charging receptacles were not working and only the 12VDC cigarette style receptacle was active. Only one cell phone could be charged by STAESS at a time and that was with USB adaptor for the cigarette style receptacle.

Recommendation: The USB charging receptacles should be made operational.

Figure 39: RTAF personnel handling simulated medicines (Left) and STAESS charging a cell phone critical to CV14 communications (Right)

Conclusions
The overall objective to test STAESS in an expeditionary environment, within a plausible scenario, while demonstrating interoperability with RTAF, was a success.

STAESS proved that it was deployable, easy to set-up, and easy to operate. STAESS successfully powered other CV14 Phase IV hardware that included the First Response 5000 water filtration and chlorination system, an experimental thermo-electric cooler, and a cell phone critical to CV14 Phase IV communications. STAESS was able to fully charge its batteries prior to noon each day and provide electricity even when sunlight was not available. RTAF users not familiar with STAESS were able to be trained and subsequently became highly proficient at operating STAESS. RTAF users were able to set-up, operate, and tear-down the equipment each day over several days. The training provided to RTAF personnel was limited to the use and operation of STAESS and did not include technically oriented maintenance or troubleshooting training as adequate documentation for this type of training was missing. Also spare parts were not available. The electrical outlets on STAESS were of the types used in North America and this limited the use of STAESS in Thailand, especially with the 240VAC outlets. STAESS would greatly benefit from some easily implemented minor design improvements including the use of multi-socket electrical outlets, a more-user friendly control panel, a listing of the technical specification printed on or attached to the STAESS case, and graphics-only instructions printed on or attached to the STAESS case.

STAESS performed very well at CV14 and would be extremely useful in actual HADR situations as well as in a wide variety of actual expeditionary conditions.

Thermoelectric Cooler

The Technology Experimentation Center (TEC), under the direction of the Pacific Command's Science Advisor, conducted a data collection and evaluation effort of a thermoelectric cooler manufactured by Sheetak, Inc., under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Chao Samran Beach Army Camp Thailand.

The thermoelectric cooler uses a thermoelectric, bi-metallic, solid state device that exhibits a temperature difference when a voltage is applied. The cold side of the device provides cooling while the hot side is vented to the atmosphere. An electric fan, heat pipe, and radiator, on both the cold side and hot side, aid the transfer of heat to and from the solid state device.

CV14 Demonstration and Assessment Support
The three thermoelectric coolers were intended to provide a portable, reliable refrigeration capability in an HADR scenario. For the scenario, the thermoelectric coolers were supposed to simulate the storage of medicines. In CV14 Phase IV, the thermoelectric coolers were powered by alternating current (AC) electricity provided from Smart PPS and STAESS, two systems which derived their electricity from photovoltaic cells. The thermoelectric coolers operated alongside other technologies that included the Smart Portable Power System (Smart PPS),

Soldier Transportable Alternative Energy System (STAESS), First Response 5000, and Renewable Area Lighting System (REAL), as part of the CV14 HADR scenario.

Figure 40: Thermoelectric cooler in CV14

One Office of Naval Research - Reserve Component (ONR-RC) officer and 11 Royal Thai Armed Forces (RTAF) personnel operated three thermoelectric coolers at the Royal Thai Army Leisure Center in the HADR exercise scenario headquarters area.

Figure 41: Location of STAESS co-located with the HADR HQ

The ONR-RC officer and 11 RTAF personnel operated three thermoelectric coolers on a daily basis along with other experimental technologies during the CV14 HADR scenario. The thermoelectric coolers were able to provide some cooling, however, exact performance parameters were not available and the amount of cooling and cooling capacity could not be objectively evaluated.

Thermoelectric Cooler Demonstration Daily Schedule and Evolutions
The following table is a summary of the daily schedule and evolutions by day followed by the Thermoelectric Cooler team.

Table 12: Daily Schedule and Evolutions

Daily Schedule			Evolutions by Day	
Time	**Event**		**Day**	**Theme**
0800-0830	Setup		20 Sep	Set up CV14 headquarters
0830-0845	Morning Meeting		21 Sep	Initial equipment set-up
0900-1145	Operations/Assessment		22 Sep	Demonstration, orientation and training on equipment
1145-1300	Lunch		23 Sep	Practice run through of HADR scenario
1300-1600	Operations/Assessment		24 Sep	Full run through of HADR scenario
1600-1700	Daily Wrap-up (All hands)		25 Sep	Demonstration of technologies to VIP's

Thermoelectric Cooler Demonstration Participants
The following table provides a summary of the participants that supported the Thermoelectric Cooler demonstration and evaluation.

Table 13: CV14 STAESS Participants

Last	First	Rank	Organization	Role
Niyomwan	Boonchana	CDR	Military Research and Development, Science Department, Ministry of Defense	RTAF HADR scenario lead
Unepan	Pitucpong	Lt Col	Army Research and Development Office	RTAF HADR scenario deputy lead
Carrizosa	Santiago	LCDR	ONR-RC	U.S. HADR scenario lead
Ferron	James	LCDR	ONR-RC	U.S. HADR scenario deputy lead
Thonthom	Deacha	Sub Lt	Signal Department	RTAF user
Sasom	Santipong	Sub Lt	Signal Department	RTAF user
Niboonthan	Chalerm	SM1	Signal Department	RTAF user
Tararam	Siri	SM1	Signal Department	RTAF user
Thongkham	Sewee	SM1	Medical Department	RTAF user
Pongsin	Suchin	SM1	Engineering Department	RTAF user
Jitharn	Chan	SM1	Engineering Department	RTAF user
Duran	Francisco	CTR*	NAVMAR Applied Sciences Corp.	U.S. user

* Contractor (CTR)

Figure 42: Smart PPS CV14 participants

Technical Specifications
The following section provides more detailed technical specification for the Thermoelectric Cooler capability. The information provided includes system specifications and benefits.

Table 14: Thermoelectric Cooler Specifications

Item	Description
Refrigeration Unit	Solid-state engine with no moving parts. Can provide cooling of 32°C below ambient with long hold times
Dimensions	27” x 16” x 15.5”
Weight	~ 10 lbs.
Electrical	AC power (with an accessory for AC to DC conversion) or 12VDC at 5.5A

Observations and Feedback
The thermoelectric coolers were lightweight and were easily transported by sea and land, to and from CV14 Phase IV. All three thermoelectric coolers were able to provide cooling to varying degrees and were used ostensibly to cool simulated medicines. The thermoelectric coolers did not demonstrate a consistent capacity to maintain a given temperature.

Objective 1: Effectiveness of the thermoelectric cooler technology.

Observation 1: The thermoelectric coolers cooled to varying temperatures after several hours of operation on days with ambient temperatures of 80-85°F.

Feedback: There were no cooling capacities or other technical specifications with which to measure the effectiveness of the thermoelectric coolers. An empty cooler cooled to 45°F. Coolers with several water bottles cooled to temperatures of 69°F and 55°F. Surely, with enough time, the coolers with the water bottles would cool to considerably lower temperature. The coolers do not have a mechanism to regulate the internal temperature of the thermoelectric coolers. One of the coolers was disassembled and the cooler only contained the bi-metallic thermoelectric solid-state device which was connected to two sets of heat pipes that transferred heat to dedicated radiators for the hot and cold side, and each of the radiators had a dedicated cooling fan. No features were observed that could regulate the temperature.
Recommendation: The technical specifications of the technology to be evaluated should be provided, along with a specific test plan. The thermoelectric cooler's internal temperature seems to be highly sensitive to the amount of items placed inside it. A device to regulate the temperature as well as device to display the temperature would be highly useful.

Figure 43: Thermoelectric cooler #1 at 45°F (Left) Thermoelectric cooler #2 at 69°F (Center) and Thermoelectric cooler #3 at 55°F on an 85°F day (Right)

Objective 2: Assess suitability for deployment (Reliability)
This objective assesses system failures or glitches, total downtime, ability to repair, user/observer rating or feedback on reliability.

Observation 1: Description of system failures and reliability. The thermoelectric coolers worked every time they received power and they did provide some cooling. But ability to cool to below a certain useful temperature was not observed.
Feedback: The thermoelectric coolers would likely not be useful for the storage of medicines as medicines would likely have specific maximum temperatures above which they would spoil or become unsafe.
Recommendation: A device to regulate the temperature as well as device to display the temperature would be highly useful.

Figure 44: STAESS providing electricity to a thermoelectric cooler.

Objective 3: Assess suitability for deployment (Portability)
This objective is to determine the portability aboard vehicles, the ability to be manually transported, and the ability to withstand rugged, expeditionary, HADR environments.

Observation 1: The coolers were easily able to be hand-carried and transported aboard vehicles.
Feedback: The thermoelectric coolers are compact, light and were able to be easily transported.
Recommendation: None.

Figure 45: A Thai easily carrying a thermoelectric cooler (Left) and Two thermoelectric coolers loaded on the back of a minivan along with the First Response 5000 pump (Right)

Observation 2: The thermoelectric coolers required a dedicated wood crate for shipping.
Feedback: None.
Recommendation: Make a Pelican case, or other similar case, be the outside of the thermoelectric cooler, thereby eliminating the need for a dedicated wood crate for shipping.

Figure 46: A thermoelectric cooler being removed from its dedicated wood crate

Conclusions

In CV14 Phase IV, the thermoelectric coolers used to store simulated medicines. Although the thermoelectric coolers did demonstrate some cooling capacity, the thermoelectric coolers lacked a way to regulate the internal temperature. Lack of temperature control would mean that if the medicines required storage at a certain temperature range, the medicines could spoil. If there were no other way to store medicines requiring refrigeration, then the thermoelectric coolers could be used as last resort.

Given that the thermoelectric coolers can accept either 120 VAC or 240 VAC electricity via their electrical adaptors, an ordinary, commercial vapor-compression refrigerator found in most homes would be the better choice to store medicines if an AC electric supply were available. There are two reasons for this. The first is that the commercial refrigerator would have a thermostat that would regulate temperature. The second is that the coefficient of performance, a measure of the efficiency of a refrigeration unit, is four to seven times lower for a thermoelectric refrigerator that it is for a vapor-compression refrigerator. This means that for a given amount of electricity, four to seven times the amount of cooling capacity is available from a commercial vapor-compression refrigerator than from a thermoelectric cooler. If the AC electricity is being supplied by a portable solar system like STAESS or Smart PPS, as was done in CV14 Phase IV, then the significant inefficiency of the thermoelectric coolers used in CV14 Phase IV would be a poor choice of refrigeration technology given limited supply of available electricity. In other words, using STAESS or Smart PPs to power thermoelectric coolers is comparable to using STAESS or Smart PPS to power highly inefficient incandescent light bulbs instead of more energy efficient LED lights.

Even though solar panels were available during CV14 Phase IV, the solar panels could not be connected directly to the thermoelectric coolers because of incompatible receptacles.

There were no technical specifications provided with the thermoelectric coolers used in CV-14, such as the coefficient of performance, cooling capacity and required power, with which actual performance could be compared.

The thermoelectric coolers were compact, lightweight, easy to use and robust. In this regard, they are suited for HADR missions. However, the given their inherent inefficiencies, a refrigeration capability for HADR missions would be better served by the use of ruggedized, commercial vapor-compression refrigerators.

First Response Water Purifier FW-5000

The Technology Experimentation Center (TEC), under the direction of the Pacific Command's Science Advisor, conducted a data collection and evaluation effort of the Soldier Transportable Alternative Energy Storage System (STAESS) manufactured by Green Path Technologies, Inc. under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 Phase IV was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Thailand.

First Response 5000 is a man-portable water filtration and chlorination system that can provide up to 5,000 gallons of filtered, chlorinated water per day. First Response 5000, as tested in CV14, was comprised of a filtrated, chlorination module, a pump module and various hoses and plumbing fittings. In CV14, the pump module was powered by AC electricity provided by the Soldier Transportable Alternative Energy System (STAESS).

The purpose of the First Response 5000 is to provide an independent, stand-alone, self-sufficient, easy-to-use, reliable source of filtered, chlorinated water for approximately 8-18 hours per day. First Response 5000 operated alongside other technologies that included STAESS, Smart Portable Power System (PPS), Renewable Energy Area Lighting (REAL), thermoelectric coolers, Smart-Direct Assessment in Real Time (Smart DART), and Emergency Pop-Up Phone and Power Network (ePOP) as part of the CV-14 HADR scenario.

CV14 Demonstration and Assessment Support

First Response 5000 provided an independent, stand-alone, self-sufficient, easy-to-use, reliable source of filtered, chlorinated water for approximately 8-18 hours per day in CV14. First Response 5000 operated alongside other technologies that included PPS, Renewable Energy Area Lighting (REAL), STAESS, thermo-electric coolers, Smart-Direct Assessment in Real Time (Smart DART), and Emergency Pop-Up Phone and Power Network (ePOP).

Figure 47: First Response 5000 filter/chlorination module and pump module

Figure 48: First Response producing filtered, chlorinated water

First Response 5000 was set-up and operated at the next to the headquarters for the CV14 HADR scenario at the Royal Thai Army Leisure Center located in Petchaburi province, Muang Petchaburi district of Thailand.

The geographical coordinates of where First Response 5000 was set up is 12° 59' 26" N, 100° 03' 17" E.

Figure 49: Location of First Response 5000 co-located with the HADR HQ

One Office of Naval Research - Reserve Component (ONR-RC) officer and 11 Royal Thai Armed Forces (RTAF) personnel operated First Response 5000 at the Royal Thai Army Leisure Center where the HADR exercise scenario headquarters was located.

The ONR-RC officer trained 11 RTAF personnel to assemble and operate First Response 5000 and it was the RTAF personnel who assembled, operated and disassembled First Response 5000 on a daily basis. Only brackish water was present at the Royal Thai Army Leisure Center. First Response 5000 can only use freshwater. A 1,000 gallon water tank filled with freshwater was used to simulate the water source. Product water was pumped directly back into the source water tank so as to save the only available source of fresh water. First Response 5000 was able to process fresh water at a rate of approximately 4,700 gallons of water per day.

Demonstration Daily Schedule and Evolutions

The following table is a summary of the daily schedule and evolutions by day followed by the First Response 5000 team.

Table 15: First Response Daily Schedule

Time	Event
0800-0830	Setup
0830-0845	Morning Meeting
0900-1145	Operations/Assessment
1145-1300	Lunch
1300-1600	Operations/Assessment
1600-1700	Daily Wrap-up (All hands)

Table 16: Daily CV14 Evolutions

Day	Theme
20 Sep	Set up CV-14 headquarters
21 Sep	Initial equipment set-up
22 Sep	Demonstration, orientation and training on equipment
23 Sep	Practice run through of HADR scenario
24 Sep	Full run through of HADR scenario
25 Sep	Demonstration of technologies to VIP's

First Response Demonstration Participants

Table 17: CV14 First Response 5000 Participants

Last	First	Rank	Organization	Role
Niyomwan	Boonchana	CDR	Military Research and Development, Science Department, Ministry of Defense	RTAF HADR scenario lead
Unepan	Pitucpong	Lt Col	Army Research and Development Office	RTAF HADR scenario deputy lead
Carrizosa	Santiago	LCDR	ONR-RC	U.S. HADR scenario lead
Ferron	James	LCDR	ONR-RC	U.S. HADR scenario deputy lead
Thonthom	Deacha	Sub Lt	Signal Department	RTAF user
Sasom	Santipong	Sub Lt	Signal Department	RTAF user
Niboonthan	Chalerm	SM1	Signal Department	RTAF user
Tararam	Siri	SM1	Signal Department	RTAF user
Thongkham	Sewee	SM1	Medical Department	RTAF user
Pongsin	Suchin	SM1	Engineering Department	RTAF user
Jitharn	Chan	SM1	Engineering Department	RTAF user
Duran	Francisco	CTR*	NAVMAR Applied Sciences Corp.	U.S. user

* Contractor (CTR)

Figure 50: First Response 5000 CV-14 participants

Technical Specifications
The following section provides more detailed technical specification for the First Response 5000 capability. The information provided includes system specifications and benefits.

Table 18: First Response 5000 Specifications

Item	Description
Model Number:	FW-5000
Production Rate	Up to 5,000 gallons per day/ 19,000 liters per day
Number of Membranes:	(2) Hollow fiber membrane modules
Pre-filter:	Cleanable 100µm filter
Post Treatment:	Activated carbon for taste & odor
Disinfection:	Chlorine injection for residual protection
Dimensions: (W x L x H)	20 in. x 24 in. x 40 in. H / 51 cm x 61 cm x 102 cm
Weight:	122 lbs / 55 kg
Intake Distance:	Up to 100 ft /30.5 m
Power:	120VAC 1-ph, 60 Hz

Observations and Feedback
First Response 5000 proved to be able to be easily transported over long distances from Hawaii to Thailand as well as be easily transported between locations in Thailand within a normal cargo truck that carried other CV-14 equipment. First Response 5000 was able to be manually carried over distance of up to 100 meters within the Royal Thai Army Leisure Center area. With the exception of a seized pump, which was fixed during initial set-up, First Response 5000 worked reliably.

Objective 1: Deployability
This objective is to determine the portability aboard vehicles, the ability to be manually transported, and the ability to withstand rugged, expeditionary, HADR environments.

Observation 1: First Response 5000, along with other CV-14 technologies, was able to be easily transported from Hawaii to Thailand, and then to the Philippines.
Feedback: None.
Recommendation: None.

Observation 2: First Response, along with other CV-14 technologies, was able to be transported between locations in Thailand by commercial vehicle.
Feedback: None.
Recommendation: None.

Observation 3: First Response was able to be carried by hand over distances up to 100 m by hand.
Feedback: Thai nationals reported that hand-carrying the First Response 5000 filter/chlorination module and the pump module was easy.
Recommendation: None.

Figure 51: First Response 5000, along with other CV-14 equipment, including PPS and the thermoelectric coolers, was able to be in a standard mini-van (Left and Center), Thai nationals carrying the First Response 5000 (Right)

Objective 2: Usability
This objective is to determine how easy or difficult it is for person to set-up and operate the technology.

Observation 1: First Response had clear, easy-to-read, and easy-to-understand operator's manual.
Feedback: Although first Response 5000 is a simple system with a small number of components, it was still of much help to have a manual to see how and where the hoses connected, how to properly bleed the system of air, and how to properly use the chlorination system. However, the operator's was too depended on text, all of it English, requiring U.S. personnel to translate certain entire portions of the instructions to RTAF personnel.
Recommendation: Re-write the operator's manual so that it consists entirely of a series of diagrams, preferably with no words, showing the overall system schematic, and the correct order of performing key set-up tasks. Maintenance and troubleshooting portions of the manual could be written in English.

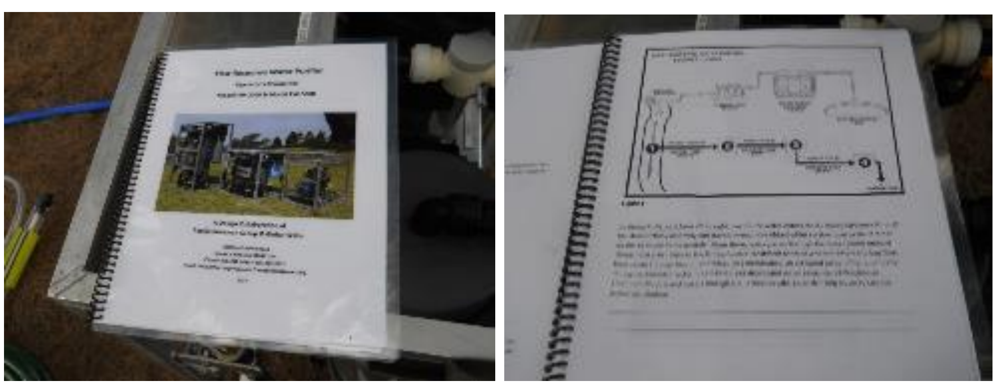

Figure 52: First Response 5000 came with an easy-to-understand operator's manual

Observation 2: First Response 5000 was set-up and disassembled four times during CV-14. The average set-up time was 10 minutes from boxed, packed components to a fully powered First Response 5000 system producing filtered, chlorinated water at a rate of approximately three (3) gallons per minute.
Feedback: First Response 5000 can be set-up very quickly and RTAF personnel were impressed by this capability.

Recommendation: None.

Figure 53: RTAF personnel assembling First Response 5000 (Left), RTAF personnel bleeding the First Response 5000 (Right)

Observation 3: The pump module had a label that indicated the pump was rated only for 120 VAC electricity. However, the nameplate on the pump motor indicated that the pump motor could be wired for either 120VAC or 240 VAC electricity.
Feedback: Because the pump could only use 120 VAC electricity, PPS could not be used to power First Response 5000 as was originally intended due to the fact that the PPS only had 240 VAC output receptacles. STAESS was used to power First Response 5000 instead.
Recommendation: The pump module should have a switch that can toggle between 120 VAC and 240 VAC electricity. When using a 60 Hz pump in conjunction with as 50 Hz power supply, it should be noted in the operator’s manual or even on the pump module itself, that the pump flowrate will be reduced by 17% (4,200 gallons per day vice 5, 000 gallons per day).

Figure 54: Label on the pump module indicating the use of 120 VAC electricity only (Left), Pump nameplate showing that the pump motor can be wired for either 120 VAC or 240 VAC electricity (Right)

Observation 4: The First Response chlorination feature was easy to use.
Feedback: The chlorination feature, along with the graduated cylinders and other peripheral components provided with the First Response 5000 including the operator’s manual, made the chlorination of the water, and subsequent testing quite easy.
Recommendation: None.

Figure 55: RTAF personnel adding chlorine to First Response 5000

Figure 56: RTAF personnel measuring chlorine levels (left) and bacterial levels (right)

Figure 57: RTAF and U.S. personnel sampling filtered, chlorinated First Response 5000 product

Objective 3: Water Production
This objective is to determine if First Response 5000 met the water requirements of the mission.

Observation 1: Over four measured trials, First Response 5000 produced 2.0 gallons in an average of 37 seconds. This corresponds to a daily production of 4,700 gallons per day.

Feedback: The 4,700 gallon per day production corresponds closely with the advertised 5,000 gallon per day production for First Response 5000.
Recommendation: Various factors such as daily maintenance periods, power interruptions, spillage, etc., would likely contribute to a lower production rate. For planning purposes, in a real HADR scenario, a more realistic production rate of 3,500 gallons per day would be recommended.

Observation 2: First Response 5000 ran for 8-18 hours each day during CV-14.
Feedback: First Response was attempted to be run for a full 24 hours, using STAESS. However, the STAESS batteries ran low during the overnight hours and thus power to the pump stopped at some point during the night. During other days, First Response ran reliably from when it was set-up in the morning, until it was taken apart and stowed in the evenings.
Recommendation: If First Response is to be used on a 24-hour basis in an actual HADR scenario, care must be taken to ensure a reliable power supply. If a portable solar system like STAESS or PPS is to be used, consideration must be given to optimum placement of the solar panels, and of monitoring energy consumption.

Objective 4: Trainability
This objective is to determine if a non-English-speaking able-person can be taught to reliably set-up, operate and maintain the equipment.

Observation 1: U.S. personnel were able to train RTAF personnel over a two day period to reliably operate First Response 5000.
Feedback: RTAF personnel were all technically or scientifically oriented and were able to understand English to varying degrees. Training was conducted in English but the method of instruction that was most successful was by physically demonstrating the set-up, operation and tear down of the equipment, and then asking the RTAF personnel to repeat the actions. RTAF personnel showed great proficiency at operating First Response 5000.
Recommendation: None.

Objective 5: Maintainability
This objective is to characterize the amount of resources are necessary to maintain the equipment in proper working order.

Observation 1: The pump was seized when first operated.
Feedback: The First Response 5000 pump likely had not been operated for an extended period of time and residual water left in the pump caused the pump impeller to become seized with the pump casing. This was likely caused by failure to drain the pump and perform long-term storage actions. U.S. personnel disassembled the pump, removed hardened deposits, and reassembled the pump. The operator's manual did not have any mention of pump drainage and storage procedures.
Recommendation: Include pump storage procedures in the operator's manual and perform these procedures if the pump unit is to be inoperable or in storage for an extended period of time.

Figure 58: U.S. personnel and Thai nationals troubleshooting as seized pump

Observation 2: Extra filters were included with the First response 5000 but additional spare parts were not available.
Feedback: Extra bag filters were included and these proved to be beneficial in the setup of First Response 5000 and also to the training of the RTAF personnel. However, the most of the items listed in Table 1 of the operator's manual, titled *Accessory Equipment Box Contents*, and were not present. In an actual HADR scenario, especially an extended one lasting one or more weeks, the additional accessories and spare parts would likely be critical for continued, reliable operation of First Response 5000.
Recommendation: Provide all of the accessory equipment listed in Table 1 of the operator's manual with the First Response 5000.

Objective 6: Mission Impact
This objective is to determine if the equipment was a mission enabler or a mission hindrance.

Observation 1: First Response 5000 was able to provide filtered, chlorinated water at a rate of 4,700 gallons per day during CV-14 HADR scenario.
Feedback: None.
Recommendation: None.

Observation 2: First Response 5000 worked well in conjunction with STAESS, which provided power, as well as with Smart Dart, a portable disease detection system that was used to test the First Response 5000 product water for disease causing microbes.
Feedback: None.
Recommendation: None.

Conclusions
The overall objective to test First Response 5000 in an expeditionary environment, within a plausible scenario, while demonstrating interoperability with RTAF, was a success.

First Response 5000 provided an independent, stand-alone, self-sufficient, easy-to-use, easy-to-transport, reliable source of filtered, chlorinated water for approximately 8-18 hours per day. The system could be set-up and disassembled in 10 minutes and the chlorination feature as simple and straight forward to use. RTAF users not familiar with First Response 5000 were able

to be trained and subsequently became highly proficient at operating First Response 5000. RTAF users were able to set-up operate and tear-down the equipment each day over several days. The training provided to RTAF personnel included the use, operation, maintenance and troubleshooting of the system. First Response 5000 had a detailed operator's manual that greatly facilitated all aspects of the operations and training evolutions in CV-14.

First Response 5000 should be deployed with the full list of spare parts and accessories listed in the operator's manual when being deployed to support actual HADR operations. The only available spares during CV-14 were extra bag filters. The First Response 5000 pump motor was wired in such as to require 120 VAC electricity even though the motor could be re-wired to accept 240 VAC electricity. Having the motor accept only 120 VAC electricity means that without a transformer, the First Response 5000 system could not be used in areas where only 240 VAC electricity is available.

First Response 5000 performed very well at CV-14 and would be extremely useful in actual HADR situations as well as in a wide variety of actual expeditionary conditions.

Emergency "Pop Up" Phone and Power Network (ePoP)

The Technology Experimentation Center (TEC), under the direction of the Pacific Command's Science Advisor, conducted a data collection and evaluation effort of the ePoP under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 Phase IV was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Thailand.

ePop is a man portable, rugged, all-weather, pop-up emergency network. The system can operate 24/7 off-the-grid using photovoltaics and battery sources. The system consists of a master node and other nodes used to create a wireless dark network. The wireless mesh nodes are self-configuring and self-healing. During CV14 Phase IV, separation of nodes averaged 50 meters.

CV14 Demonstration Support

ePop provided communications support to the HADR/Medical scenario during CV14 Phase IV, including rapid deployment of a self-healing mesh network for communications. During CV14 Phase IV ePoP was used reliably for Broadcast and P2P Text messaging, intermittently for P2P Voice Communications, and unsuccessfully for picture and file sharing.

CV14 Phase IV took place in Hat Chao Samran, Mueang Phetchaburi District, Phetchaburi, Thailand. ePoP hardware was positioned throughout the Military installation and Mangrove at increments of 45-60 meters.

Figure 59: ePoP node locations during CV12 Phase IV

ePoP Demonstration Daily Schedule

The following table is a summary of the daily schedule and evolutions by day followed by the ePoP team.

Table 19: ePoP Daily Schedule

Date	Event
9/20/14	Equipment Delievery
9/21/14	Equipment Setup
9/22/14	Training
9/23/14	Partial Vignettes
9/24/14	Full Vignettes
9/25/14	VIP Demonstrations Equipment Breaking down and Packout
9/26/14	Equipment Shipping

ePoP Demonstration Participants

Participants included members of the US Army Research Development & Engineering Command (RDECOM), US Army Reserve Sustainment Command (ARSC), Royal Thai Army (RTA), Royal Thai Navy (RTN), Royal Thai Air Force, and Thai Military Research & Development Facility (MRDC).

The following table provides a summary of the participants that supported the ePoP demonstration and evaluation.

Table 20: ePoP Participants

Name	Rank	Unit
Kantima Niweswan	CAPT	RTA Chemical Department
Samart Preeklang	CAPT	RTA Medical Department
Aumnart Surthong	SM1	RTA Signal Department
Tasapol Ngamtuan	SUB LT	MRDC Office of the Permanent Secretary for Defence
Jirachai Pudpong	GP CAPT	Military Research and Development Center (MRDC)

Figure 60: CV14 Phase IV ePoP Team

Technical Specifications

The following section provides more detailed technical specification for the Thermoelectric Cooler capability. The information provided includes system specifications and benefits.

Table 21: Advanced ePoP System Specifications

Wireless Mesh Nodes Specifications
Self-Configuring/Self-Healing Network
WiFi 802.11n/300mbps/MIMO
Frequency Flexibility – 802.11, military, or public-safety frequencies
Coverage of 3-5 fields per node (line of site considerations)
FIPS 140-2 compliant, military grade 256-bit ciphers
Powered by photovoltaic and batteries
Provides voice, text, video, location sharing

ePoP CV14 Phase IV Objectives

Objective tasks were identified for the ePoP capability to support the CV14 Phase IV HADR/Medical scenario. These objectives included:

- **HLZ Site:** Collect/send photos, GPS coordinates, and est. measurements of HLZ and staging area to COC
- **Water Port Site:** Collect/send photos, GPS coordinates, and pier capacity to COC
- **Meet with local officials at affected area, survey damage:** Collect/send photos, GPS coordinates of damaged area to COC
- **Meet with local officials at affected area, survey damage:** Collect and send village leader POC information to COC
- **Drinking Water Viability:** Take Smart-DART readings and send results back to the rear for interpretation
- **Notify Officials and Populous of the following:**
  - Notify locations of water source contamination, warning and recommended actions (i.e. boil water) per local government
  - Notify locations of water purification operations, operating hours, capacity (GDP/Lpd), distribution (x gal. or y liters per person) and to bring water containers when possible

- Notify locations of supply distribution operations and types of supplies available (e.g. blankets, tarps, food, etc) including medicines

Observations and Feedback

Objective 1: Assess effectiveness of the ePoP network
ePop technology was successfully assessed to successfully complete/support HADR missions.

Observation 1: Effective Range of the ePoP Network
ePoP nodes were tested to be most effective in the 50-75 meter range. It is assumed that nodes are equally effective at shorter distances but it is impractical to position them that closely in a real world mission, so this was not assessed. Also, interference became an issue at distances of 75-100 meters or greater, however this is presumed to be caused by local commercially available WIFI.

Observation 2: Power Usage
ePoP nodes were tested to be most effective when solar panels could be placed in a location with constant direct sunlight and the case, tripod, and antenna could be laced in a location with constant shade.

Observation 3: Weather
ePoP nodes were tested to be most effective when the weather was clear and sunny.

Objective 2: Assess Reliability

Observation 1: System Failures: Users observed and reported numerous ePoP system failures.

- **Overheating:** Numerous ePop Nodes overheated causing system failure. This was resolved by takin g the unit out of service for several hours allowing it to cool and then redeploying the node.
- **Case/Cable Penetration Points:** Numerous ePoP Nodes were had or experienced broken case/cable penetration points. Four cases were dead lined because their case/cable penetration points were damaged beyond repair in transit. Four cases were repaired by users because their case/cable penetration points were dislocated in transit.

Observation 2: System Reliability: Users observed and reported numerous ePoP system reliability Issues.

- **Overheating:** Numerous ePop Nodes overheated causing reliability issues failure. This was resolved each time by opening the case allowing it to cool for a few minutes and repositioning it to an environment with more shade.
- **Tripod Strap Supports:** Numerous ePoP Nodes were had or experienced broken tripod strap supports. This plastic piece that allows the case to be used to weight down the tripod. This was overcome by securing the strap around the legs of the tripod directly.

Objective 3: Assess Other Suitability Aspects

Observation 1: User/Observer observations on ease of setup/operation

Users observed and reported extreme ease of set and operation. ePop nodes could me setup with minimal training in 2-3 minutes with a team of two users.

Figure 61: RTA users setting up ePoP

Observation 2: Vulnerability of the system to theft and/or tampering
Users observed and reported that ePop nodes were highly susceptible to theft and/or tampering. ePop nodes could me packed in 1-2 minutes with a team of two users.

Objective 4: Assess the mission impact of the ePoP software
ePop is a low cost and easily deployable communications technology. The ePoP nodes (hardware) together with the Serval Mesh Android Application (software) broadcast messaging and point to point (P2P) messaging had a high impact on the mission success. However, echoing and static made the voice communications almost unusable. Additionally, file and photo sharing did not work as the functionality was not operable in the current version of the Serval Mesh Android Client.

Observation 1: Address whether the smartphone the only means of communications needed for command and control in an HADR mission.
Users observed and reported that ePop nodes with minor improvements to the Android Client would be suitable as the only means for command and control in an HADR mission.

Figure 62: ePoP user collecting water sample and sending results using the ePoP network

Observation 2: Which features were useful for HADR response operations? Address whether the ePoP app is necessary to do text messaging/voice comms/file sharing over Wi-Fi given that users can download any app to the smartphone.
Users observed and reported that ePop nodes in conjunction with Serval Mesh Android Application were able to be used reliably for Broadcast and P2P Text messaging, intermittently for P2P Voice Communications, and unsuccessfully for picture and file sharing.

Other Observations if relevant and time/schedule permits:

- **Interoperability:** Not observed, ePoP was not interoperable with any other technologies during CV14.
- **Training:** No training materials were provided to the instructor/assessor prior to the exercise. User training materials should be provided in both Thai and English for future exercises.
- **Maintainability:** The technology is inexpensive modular and disposable and therefore easy to maintain with an adequate supply of spare/replacement parts.

Conclusions
ePop is a man portable, rugged, all-weather, pop-up emergency network. The system was used successfully during CV14 Phase IV to support a notional HADR/Medical scenario using off-the-grid photovoltaics and battery sources. During this exercise separation of nodes averaged 50 meters. The ePoP nodes (hardware) together with the Serval Mesh Android Application (software) broadcast messaging and point to point (P2P) messaging had a high impact on the mission success. However, echoing and static made the voice communications almost unusable. Additionally, file and photo sharing did not work as the functionality was not operable in the current version of the Serval Mesh Android Client. The Thai users provided positive feedback about the simple design and setup of the ePoP network. The inexpensive design using commercial off the shelf hardware would allow for easy procurement when responding to an HADR event. DSTD requested that ePoP nodes be left behind for continued assessment after CV14 Phase IV.

Smart-Direct Assessment in Real Time (Smart-DART)

The Technology Experimentation Center (TEC), under the direction of the Pacific Command's Science Advisor, conducted a data collection and evaluation effort of the Smart-DART capability under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief (HADR) exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 Phase IV was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi province, Muang Petchaburi district of Thailand.

Smart-Direct Assessment in Real Time (Smart-DART) Gene Based Detection Kit is an Android Application Operated Testing System. The system can be used to test consists of the Smart-DART Device and Android Tablet with Software Application. The system was used to successfully test dozens of water samples for Ecoli during CV14.

CV14 Demonstration Support

Smart-DART technology was a valuable source of water testing during the CV14 Phase IV. As part of the CV14 Phase IV, Thai users successfully tested dozens of water samples, finding E-coli where expected as well as in the positive control in all but one test.

Figure 63: RTA users processing samples

CV14 Phase IV took place in Hat Chao Samran, Mueang Phetchaburi District, Phetchaburi, Thailand. Smart-DART testing was performed at the headquarters. Testing samples were gathered from sources throughout the military installation and mangrove farm.

Smart-DART Demonstration Schedule

The following table is a summary of the daily schedule and evolutions by day followed by the Smart-DART team.

Table 22: Smart-DART

Date	Event
9/20/14	Equipment Delievery
9/21/14	Equipment Setup
9/22/14	Training
9/23/14	Partial Vignettes
9/24/14	Full Vignettes
9/25/14	VIP Demonstrations Equipment Breaking down and Packout
9/26/14	Equipment Shipping

Smart-DART Demonstration Participants

Participants included members of the US Army Research Development & Engineering Command (RDECOM), US Army Reserve Sustainment Command (ARSC), Royal Thai Army (RTA), Royal Thai Navy (RTN), Royal Thai Air Force, and Thai Military Research & Development Facility (MRDC).

The following table provides a summary of the participants that supported the Smart-DART demonstration and evaluation.

Table 23: Smart-DART Participants

Name	Rank	Unit
Kantima Niweswan	CAPT	RTA Chemical Department
Samart Preeklang	CAPT	RTA Medical Department
Aumnart Surthong	SM1	RTA Signal Department
Tasapol Ngamtuan	SUB LT	MRDC Office of the Permanent Secretary for Defence
Jirachai Pudpong	GP CAPT	Military Research and Development Center (MRDC)

Figure 64: CV14 Phase IV Smart-DART Team

Technical Specifications

The following section provides more detailed technical specification for the Thermoelectric Cooler capability. The information provided includes system specifications and benefits.

Table 24: Smart-DART Platform Specifications

Specification	Details
Dimensions	IV.5" x 3.75" x 2.5"
Weight	1 lbs.
Test Wells	8
Optical Channels	2
Power	12V nominal
Battery Life	20 hours / ~320 reactions
Interface	Bluetooth enabled, Android device

Smart-DART CV14 Phase IV Objectives

Objective tasks were identified for the Smart-DART capability to support the CV14 Phase IV HADR/Medical scenario. These objectives included:

- **Drinking Water Viability:** Take Smart-DART readings and send results back to the rear for interpretation
- **Based on Test Results, Notify Officials and Populous of the following:**
  - Notify locations of water source contamination, warning and recommended actions (i.e. boil water) per local government

- Notify locations of water purification operations, operating hours, capacity (GDP/Lpd), distribution (x gal. or y liters per person) and to bring water containers when possible
- Notify locations of supply distribution operations and types of supplies available (e.g. blankets, tarps, food, etc) including medicines

Observations and Feedback

Objective 1: Assess effectiveness of the Smart-DART Technology
Smart-DART Technology was successfully assessed to successfully complete/support HADR missions.

Observation 1: Portability of the Smart-DART Technology
Smart-DART Technology was observed to be highly portable and able to be packed into two small Pellican Cases. This is critical to rapid deployment to HADR area.

Observation 2: Durability of the Smart-DART Technology
Smart-DART Technology was observed to be highly durable and 100% capable of withstanding expected distress caused by HADR environment. Associated Android tablets were observed to be less than 100% capable of withstanding expected distress caused by HADR environment. A 25% failure rate of Android Tablets (1 of IV) was reported. Users suggested including a protective case to reduce/eliminate this problem.

Observation 3: Power Usage
Smart-DART Technology was observed to be highly portable and capable of being run/charged using alternate power/solar panels. This is critical to continuous usage in deployment to HADR area.

Objective 2: Reliability of the Smart-DART Technology

Observation 1: System Failures: Users observed and reported no Smart-DART Technology system failures. .

Observation 2: System Reliability: Users observed and reported no Smart-DART Technology system failures.

Objective 3: Assess Other Suitability Aspects

Observation 1: User/Observer observations on ease of setup/operation
Users observed and reported extreme ease of set and operation. Smart-DART Technology and all associated testing equipment could be setup with minimal training in 30-60 minutes with a team of two users.

Observation 2: Vulnerability of the system to theft and/or tampering
Users observed and reported that Smart-DART Technology were susceptible to theft and/or tampering but this was mitigated by the necessity to perform testing in a secure location.

Objective 4: Assess the mission impact of the ePoP software
Smart-DART Technology is a low cost and easily deployable testing technology. Smart-DART had high impact on the HADR mission success.

Observation 1: Address Smart-DART Technology as the only means of testing in an HADR mission.
Users observed and reported that Smart-DART was fully capable to function as the only means of testing in an HADR mission.

Observation 1: Address Smart-DART Technology as a supplemental means of testing in an HADR mission.
Users observed and reported that Smart-DART was fully capable to support other means of testing in an HADR mission.

Other Observations if relevant and time/schedule permits:

- **Interoperability:** Not observed, Smart-DART Technology was not interoperable with any other technologies during CV14.
- **Training:** Training materials for the Smart-DART Technology were provided to the instructor/assessor just prior to the exercise. None of the materials were provided in Thai. Primary Trainer used Google Translate to provide Thai Users with printed training materials in their native language. Training materials should be provided in both Thai and English for future exercises.
- **Maintainability:** The Smart-DART Technology is inexpensive, highly portable, highly reliable and disposable and easy to operate.

Conclusions
Smart-Direct Assessment in Real Time (Smart-DART) Gene Based Detection Kit is an Android Application Operated Testing System. The system can be used to test consists of the Smart-DART Device and Android Tablet with Software Application. The system was used to successfully test dozens of water samples for Ecoli during CV14 Phase IV. Thai users were quickly trained on the technology and able to operate it without guidance after only a couple of days. Thai users provided positive feedback on the technology and noted the value of its lightweight, portable, and inexpensive design. This technology has the potential to provide a valuable tool to responders in HADR missions.

Persistent Ground Surveillance Tower (PGST) Sensors Technologies and Common Operating Picture (COP) for Counter-Improvised Explosive Devices (C-IED) Missions and PGST Mobile COP

The Technology Experimentation Center (TEC), conducted a data collection and evaluation effort of the Persistent Ground Surveillance Tower (PGST) sensor technologies and common operating picture for counter-improvised explosive device (C-IED) missions under expeditionary conditions, and as part of the Humanitarian Assistance / Disaster Relief exercise scenario, during Phase IV of the 2014 edition of the annual Crimson Viper Field Experiment (CV14) in the Kingdom of Thailand from September 18-26, 2014. Phase IV of CV14 was conducted at Royal Thai Army Leisure Center and the adjacent Chao Samran Beach Army Camp located in Petchaburi Province, Cha-Am district of Thailand.

During CV14 Phase IV two aspects of the PGST capabilities were demonstrated and evaluated. The first aspect was the PGST Mobile COP. This newly developed mobile capability provides the user access to PGST assets on handheld electronic devices. The next aspect of the PGST demonstrated and evaluated during CV14 Phase IV was the utilization of PGST assets in C-IED missions. The following sections provide a summary of the scenario, operations, observations, and feedback resulting from the PGST demonstration and evaluation effort.

The PGST is a fielded, land-based system used to support situational awareness (SA) around a forward operating base (FOB). The PGST detects and monitors activities and persons of interest with various advanced sensors and can be custom crafted to a customer's requirements and mission parameters. The PGST provides intelligence, surveillance, and reconnaissance (ISR) capabilities through an electro-optical (EO)/infrared (IR) full-motion video (FMV) camera, a maritime moving target indicator (MTI) radar, and AIS receiver. Sensors are mounted on an 80-foot tower to extend the sensor line of sight and effective range. Sensor data is fed into the common operating picture (COP) to provide the operator a central display. PGST can be modified with maritime radars and Automated Information System (AIS) receivers to enable maritime situational awareness (MSA) development and support. The maritime radars can also be modified for land situational awareness development and support.

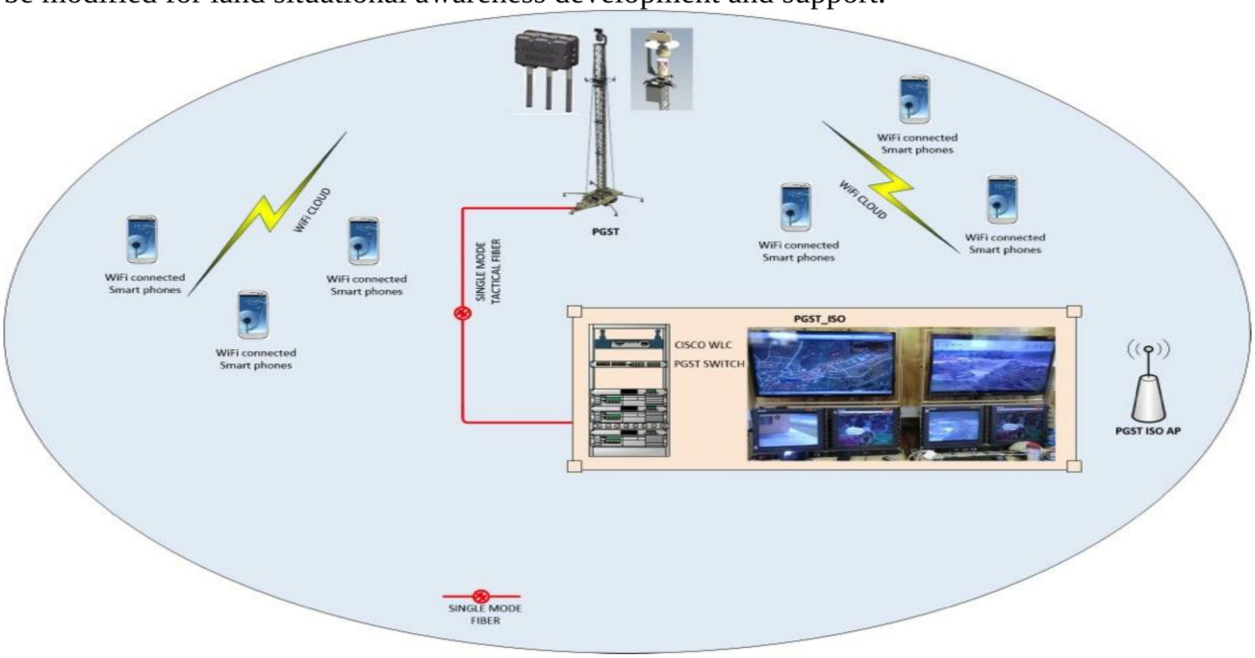

Figure 65: PGST Network Topology

CV14 Demonstration and Assessment Support

The Command Guard Shack was set up to simulate a Remote Tactical Operation Center (RTOC) using the sensors form the PGST to collect and populate the Common Operating Picture (COP) with targets considered to be possible threats as per the scenario dictated. Due to the short set up time available, issues with equipment working, no spares available for repair, and limited ability to trouble shoot software issue that occurred while trying to integrate the sensors to the COP, the PGST operated independently from the first responders in the scenario and focused on accomplishing the C-IED mission. Using the "Teach, Coach, Mentor" approach of familiarizing the 11 Thai officers with the technology, the Thai Officers from all 3 branches of Service (Air Force, Army, and Navy) were quickly able to operate the basic controls of the EO/IR camera.

Figure 66: PGST Setup (Left) and RTA and RTN PGST Setup Brief (Right)

PGST COP/C-IED and Mobile COP Scenarios Schedule

The following table is a summary of the daily schedule and evolutions by day followed by the PGST team.

Table 25: PGST COP/C-IED Schedule

Day	Morning Event	Afternoon Event
21 September	Receive Equipment	Set up equipment
22 September	Equipment Familiarization	Phase 1 of scenario
23 September	Phase 2 of scenario	Phase 2 of scenario
24 September	Phase 3 of scenario	Phase 3 of scenario
25 September	VIP demonstration	End of Exercise

Figure 67: Equipment Familiarization and Training

PGST COP/C-IED and Mobile COP Scenarios Participants
One Office of Naval Research (ONR-RC) officer, one Royal Thai Air Force (RTAF) officer, three Royal Thai Naval officers from the Naval Research and Development Office, IV Royal Thai Army (RTA) officers from the RTA Ordnance Department, and IV RTA officers from the Army Research and Development Office operated PGST at the Chao Samran Beach Army Camp.

CV14 PGST COP/C-IED and Mobile COP Scenarios Objectives
The following Objectives were established in evaluating the PGST:

- Assess effectiveness of the PGST and associated sensors for counter-IED missions.
- Assess effectiveness of the COP feed in the JOC for counter-IED missions.
- Assess suitability of the COP feed in the JOC for counter-IED missions.
- Assess the mission impact of the COP feed in the JOC.

PGST COP/C-IED and Mobile COP Scenarios
As part of the CV14 Phase IV event the data collected from the sensors on the PGST was sent to the Remote Tactical Operations Center (RTOC) which held the compact 1U server which provides fusion of video, operations, and intelligence data onto a Common Operation Picture (COP). The COP is a correlation of multiple sensors' feeds producing single, high confidence track then cross cue to target by: Integrating SIGINT, RADAR, EO/IR Video Sensors underway, Wide Tracker & multiple hypothesis tracker, and Correlation and display of GMTI and Multi-intelligence tracks. By feeding the data into COP, the operator was provided a central display and able to develop an accurate situational awareness of the area under observation. This central display contained the video, radar, and other sensor data collected by the PGST on one screen and saves the information for future play back.

Figure 68: Thai operators using COP while manning RRTOC.

The PGST was set up just outside of the Chao Samran Army Camp on the beach. The beach was leveled to allow the PGST to be easily deployed while also removing interferences of the surrounding forest. With the PGST being located on the beach, the area of observation consisted of the Bay of Thailand, its coast, and the street that ran parallel to the Army Camp. Inland areas that did not have roadways were either covered in thick foliage or wet lands.

Figure 69: Road parallel to Army Camp used for C-IED scenario (Left) and Road next to RRTOC used for C-IED scenario (Right)

The C-IED and Mobile COP scenarios were executed using a “Crawl, Walk, Run” approach in order to establish a training schedule for the Thai military personnel to become familiar with the equipment as well as allow the PGST support team members from NAVMAR the opportunity to set up and trouble shoot issues as they were discovered. Due to the complexity of the PGST systems and the very short schedule to prepare for the scenario, the scenario was broken down into IV phases to ensure the full potential of the system was utilized.

Phase One (“Crawl”) involved using the EO/IR cameras on the PTSG to locate a roadside IED located just outside established roadside checkpoints. The Thai officers were broken down into two groups of 3 who walked out to patrol a small stretch of road next to the PGST. The remaining four Thai officers manned and operated the RTOC. The Thai officers were all equipped with the Agean Android Mobile App as a means of establishing communications between checkpoints and the CGS. Each group was provided a NAVMAR instructor who used a “Teach, Couch, Mentor” approach in training the Thai operators on the use of the PTSG as well as the Agean Android Mobile App.

Phase Two (“Walk”) involved using the Agean Android Mobile App to detect a potential VBIED, relay a picture to the RTOC for identification, and search for the possible VBIED using the sensors available on the PGST. Two groups of three would set up check points away from the PGST in the blind spots and relay pictures of a potential VBIED back to the RTOC. The RTOC would than use the available sensors to locate and monitor the VBIED.

Phase Three (“Run”) involved using the multiple Agean Android Mobile Apps lead by the Thai Officers in an establishing a grid to identify possible VBIEDs, submit a picture to the RTOC and other Agean Android Mobile App operators, search for the possible VBIED (using the sensors available on the PGST), and relay the information to a Quick Reaction Force (QRF) using the Agean Android mobile App.

Phase Four (“Run”) involved using the Agean Android Mobile Apps lead by the Thai Officers in an established grid to identify possible VBIEDs, submit a picture to the RTOC and other Agean Android Mobile App operators, search for the possible VBIED using the sensors available

on the PGST, relay the information to a Quick Reaction Force (QRF), and finally the QRF would locate and detain the possible VBIED.

NOTE: Due to inadequate set up time for the exercise, only phase 1 and phase 2 were executable. Phase 1 was executable, but encounters severe issues using the Agean Mobile Aps chat function as the primary means of communication. Phase 2 was only partially executable due to the issues related with the radar sensor. Radar sensor was unable to discriminate between land based contacts and water based contacts. PGST team was unable to discover root cause of error due to extremely compressed schedule. Phase 3 was not executable due to Agean Android Mobile App lacking the ability to receive information transmitted from the PGST to the QRF team. Phase IV was not attempted.

Mobile COP Scenario Observations and Feedback
Using the information collected during equipment familiarization and enacting the scenario, observations were collected using a combination of group discussion and response to questions from the 11 Thai Officers who participated in the demonstration. The recommendations section is a compilation of information gathered by the presenters, the Thai Officers, and the ONR-RC evaluator observing the presentation.

NOTE 1: Due to the inability to acquire a motorcycle, a van was used to simulate a VBIED in its place.

NOTE 2: Phase 1 was designed as the "Crawl" phase used primarily as a training day for the Thai operators and PGST team. Phase 1 of the scenario relied on the Agean Android Mobile App as a means to communicate between the 2 groups on patrol and the RTOC. The immature nature of the technology of the Agean Android Mobile App only served to compound the communication barriers encountered between the Thai and English speaking PGST team.

The intention was to discover the strengths and weaknesses of the PGST and sensors as well as the capabilities of the Thai operators while operating in a compressed schedule. The Thai operators quickly caught on to how the operate the equipment in the RTOC and how the COP displayed its data. The ability of the Thai operators to adapt to the use of the COP even with the language barrier was critical in the execution of the scenario in the days to come.

After 2 hours of trying to overcome the communication barrier, the Agean Android Mobile App proved too difficult to incorporate into the scenario. The Thai operators became very frustrated with the inability to communicate with the RTOC using the chat function. With the technology to immature to be operated by a novice, the PGST team was manning the mobile apps and communicated to each other. All members were focused on the Agean Android Mobile App trying to make the chat function work as designed. At one point the scenario completely stopped as a result of all members ignoring the COP, surrounding environment, and scenario itself.

The Thai operators decided it was more effective to abandon using chat as a means of communication and switched to radio communications. The choice to switch to radio communications greatly allowed for the scenario to continue as designed. This was also very beneficial to the PGST team members as it allowed them to focus the little time they had available to them to configure the PGST sensors to full operational ability for the rest of the scenarios.

Objective 1: Observe the PGST, COP, and sensors' strengths and weaknesses as discovered by the Thai operators as they execute the IV phases of the scenario.

Observation 1: The PGST, sensors, and COP required more than 2 days for setting up and configuring.
Feedback: With equipment arriving from customs on the 21 September, the PGST team had only 1 day to unload, install, and configure the PGST, sensors, and COP to fully operational status. The short time period proved inadequate for the execution of the IV phases of the scenario. In order for the scenario to be executed correctly, the PGST should be able to be deployed, set up, and fully operational in days. The current configuration requires a minimum of 2 weeks before it would be fully operational.
Recommendation: Even though the PGST team members work tirelessly to accomplish the set up and configuration of the PGST, sensor, and COP, the short time frame proved inadequate to support the goals of the scenario. More time must be allowed to for the set-up of the equipment especially for deployment into an expeditionary environment. Due to unreliability of internet in the region, it is recommended to update the software before it is deployed to an area depicted in the scenario.

Observation 2: The COP was in the wrong language for the operators using it.
Feedback: With the COP and sensors all displaying the data in English, a communication barrier was introduced into the ability of the Thai officers in exploiting the full potential of the equipment. The Thai officers were limited in the ability of the translator's interpretation of the data being presented to him by the PGST team Subject Matter Experts. This was further compounded by the inability of the Thai officers to make changes to the COP due to the English keyboard.
Recommendation: Provide a translator with a background and experience level capable of translating the English explanation of the COP to Thai or develop a version of the COP in Thai.

Observation 3: PowerPoint presentations explaining PGST, COP, and Smart phone were in English.
Feedback: The pre-brief of the PGST and its sensors was very limited in its ability to educate the Thai audience. The Thai audience appeared disinterested in the presentation as a result of the in ability to communicate effectively. The Thai audience was very professional in its acceptance of the communication barrier, but showed signs of disappointment.
Recommendation: Using the experiences of Afghanistan as a means to relate the uses of the PGST and the capabilities of its sensors proved in adequate in developing an understanding of the potential of the system. Having the pre-brief translated into Thai and using examples related to the region and relevant to the experiences of the Thai is necessary for the communication barrier to be crossed. This will allow for an open discussion of the PGST to occur before the scenario is executed.

Observation 4: Training was inadequate for the time period allowed. COP relied heavily on experienced operators to be effective.
Feedback: Due to the complexity of the COP and the coordination of using the PGST and it multiple sensors, the learning curve of the Thai operators was too steep for the technology to be properly executed. This compounded with the communication barrier of the translators

and the equipment in English. The scenario was limited in its ability to effectively demonstrate the technology.
Recommendation: Since the PGST and capability of the sensors is limited to the experience and ability of the personnel operating it and in interpreting the sensor data, a multi week training program should be established for a set of Thai operators before the exercise is executed. The Thai operators should be taught how to operate the PGST the same as an American operator. These same Thai operators should be than used to demonstrate the technology during Exercise Crimson Viper. Using the "Train the Trainer" approach, the communication gap between English and Thai can be overcome resulting in a higher quality of qualitative data in the form of user feedback.

Observation 5: Training was inadequate for the time period allowed. Ageon Mobile App relied heavily on experienced operators to be effective.
Feedback: Using the Smart phone as the primary means of communication compounded the communication barrier experienced by the Thai operators and the PGST team. The Smart phone was simple to use by an English speaking operator, but when translated to Thai, the difficulty increased depending on the level of understanding of the translator.
Recommendation: A "Train the Trainer" approach is recommended as a means to demonstrate the capabilities of the Smart phone. Before the exercise is executed, the translators should be taught how to use the Smart phone in a classroom environment. When day when of the exercise begins, the translators can present to the students how to operate the Smart phone and explain how it communicates with the COP. This will allow for a foundation of knowledge to be established and built upon as the exercise progresses.

Observation 6: The Smart phone screen was very difficult to see in the sun.
Feedback: During phase 1 of the scenario, the Thai operators were having many difficulties seeing the messages displayed on chat. These difficulties became very disruptive to the scenario causing it to stop at several points during the exercise. All 11 Thai operators found this feature to be a very negative contribution to the Smart phones usability.
Recommendation: Research COTS products to mitigate this issue.

Observation 7: The Smart phone caused low levels of situational awareness of the scenarios by the operators.
Feedback: The operators of the Smart phones were distracted by the use of the phone. The operators spent increase amount of time looking down at the phone and not enough time maintaining situational of the environment they were in. When communication issues became more dominate, the Situational Awareness rapidly decreased due to all personnel focused on the Smart phone to awaiting a response. After 3 hours of this occurring, the Thai operators voiced their frustration and recommended switching to radios as the primary means of communication.
Feedback: Establish a means to use voice communications. This will allow the operators to keep their heads up and maintain situational awareness. When asked, "What is the one application you wish the Smart phone had that was not currently present? All 11 Thai operators recommended an ability to use voice communication instead of chat as the primary means of communication.
Note: Due to the delays in receiving the equipment from Customs and the inadequate set up time before the execution of the scenarios, evaluation of the PGST and its associated sensors was limited. Reliability of the equipment cannot be evaluated as a result of the PGST and

sensors not being fully set up and configured. Maintainability of the PGST and sensors was not evaluated either for the same reasons.

Objective 2: Assess effectiveness of the outdoor Wi-Fi network to support HADR and C-IED missions.

Observation 1: Effective range of each Wi-Fi node

Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. The PGST team set up the Wi-Fi network on a space available status in order focused on supporting the PGST requirements. With the dense vegetation in the area, the difficulties with the Mobile APP, and the limitations in having only one translator, the scenarios where conducted nearby the PGST sight.

Observation 2: Address whether the network supported bandwidth requirements of the vignettes.

Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Objective 3: Assess suitability of the outdoor Wi-Fi network for deployment (Reliability)

Observation 1: System failures

Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Objective 4: Assess effectiveness of the PGST Mobile COP software for HADR missions.

Observation 1: How effective was the software in determining blue force locations (of the QRT and PGST tower itself)?

Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 2: Which features of the PGST mobile COP were useful for HADR response operations?

Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Objective 5: Assess the mission impact of the PGST COP software for HADR missions.

Observation 1: Given that you can download any app to the smartphone, is the smartphone the only means of communications needed for command and control? If not, what's missing?

Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 2: Was there a need to incorporate text messaging in the PGST Mobile COP app?

Due to the inadequate set up and configuration time, the PGST team was unable to set up the

sensors to allow for them to be effectively evaluated.

Objective 6: Assess effectiveness of the PGST Mobile COP for counter-IED missions.

Observation 1: Address the effectiveness of the software for accessing PGST sensor feeds and determining sensor target location (where the sensor is looking).
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. The Mobile App was capable of taking pictures and sending them to the RTOC, but there was a delay in receiving the pictures on the COP. The Chat function itself also had a delay in providing updates to the JTOC regarding pictures that were sent. The inexperienced Thai operators did not know the pictures were available on the COP unless the PGST team showed them.

Observation 2: Address whether the QRT smartphone user had timely, accurate, complete and relevant information to identify motorcycle IED threats.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. The Smart phone could send pictures but could not retrieve pictures from the JTOC. The Smart phone would chat with the JTOC, but if the operators did not constantly look at the Smart phone, they would not know a chat message was transmitted. When the Smart phone worked, it caused much confusion in the JTOC among both the Thai operators and the PGST team. Due to its delays and limitations in its ability to function as a communication tool, it was replaced by radios as the primary communication tool after the first day of use.

Observation 3: Address whether the QRT smartphone user had timely, accurate, complete, and relevant information for the QRT to respond to a motorcycle IED threat.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. This scenario was not accomplished.

Objective 7: Assess usability of the PGST Mobile COP.

Observation 1: Address whether the software was user friendly for locating blue forces.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. Scenario was not tested.

Observation 2: Address whether the software was user friendly for accessing PGST sensor feeds and determining sensor target location (where the sensor is looking).
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. Difficulties with having only one translator and the Mobile Smart phone unable to use Thai as the operating language prevented this observation from being effectively evaluated.

Objective 8: Assess the mission impact of the VSAT for command and control in an HADR scenario.

Observation 1: Address how reach back comms was used by the CV14 FWD JOC.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 2: Address how reachback comms was used by the Smartphone user (e.g., to download apps, access CV14 Twitter, etc.)
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 3: Address whether reachback communications enabled effective situational awareness for the CV14 REAR.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Objective 9: Assess the mission impact of the VSAT for command and control in a C-IED scenario.

Observation 1: Address how reach back comms was used by the CV14 FWD JOC.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 2: Address how reach back comms was used by the Smartphone user (e.g., to download apps, access CV14 Twitter, etc.)
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 3: Address whether reach back communications enabled effective situational awareness for the CV14 REAR.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Conclusions
Due to the short set up time available, issues with equipment working, no spares available for repair, and limited ability to trouble shoot software issue that occurred while trying to integrate the sensors to the COP, the PGST operated independently from the first responders in the scenario and focused on accomplishing the C-IED mission. The tireless commitment and dedication of the members of the PGST team in setting up and troubleshooting the issues that arose daily with the equipment was pivotal to the daily success of the scenarios. The patience of the 11 Thai operators and their corresponding contributions were instrumental in the execution of each phase of the scenario. Even with the "Crawl, Walk, Run" approach to executing the C-IED mission, only the first two of the four phases were executable and provided limited amounts of credible data for analysis.

With only 2 of the IV phases of the scenario executable, the qualitative information gathered during the exercise exposed many weaknesses of the PGST. The estimated 2 week time period required to deploy, set up, and configure the PGST, sensors, and COP proved to be too long for a scenario requiring a rapid response. A combination of training, planning, and equipment preventative maintenance would be required in order to accomplish this type of a scenario. A longer set up time would be allowed for IED scenarios due to the techniques, tactics, and procedures already established to counter this type of threat.

When the Thai operators were asked if they felt the scenario was too difficult, all 11 agreed it was set at an appropriate level of difficulty. All 11 Thai operators felt confident in operating the system but would like to see sensors configured to the PGST. The Naval officers wished to see the commercial radar work for the water, but the RTA officers wanted to see the commercial radar set up for land contacts. All personnel wished to see more C-IED technologies and expressed interest in seeing the Under Ground Sensors (UGS) incorporated into the COP. In conclusion, the PGST, sensors, and COP showed much potential for C-IED operations, but exposed many weakness as well. The COP proved to be only as effective as the sensors supplying it data, but is hindered more by the quality of training of the personnel who operate it. Set up time of the whole system requires extensive planning and logistical coordination for continued mission success.

The Smart phone App proved to be to new of a technology to be incorporated with the PGST C-IED scenario. Two full days were dedicated to setting up the equipment and training the Thai operators. Even with the "Crawl, Walk, Run" approach, not enough time was available to trouble shoot the equipment issues while also effectively training the operators. With most of the events regarding the Smart phone unable to be effectively executed, the discovery of the difficulties with seeing the screen in the sun, language barrier, and lack of a voice communication option will provide an opportunity for the Ageon Mobile App to achieve its full potential.

PGST COP/C-IED Scenario Observations and Feedback

Objective 1: Observe the PGST, COP, and sensors' strengths and weaknesses as discovered by the Thai operators as they execute the IV phases of the scenario.

Observation 1: The PGST, sensors, and COP required more than 2 days for setting up and configuring.
Feedback: With equipment arriving from customs on the 21 September, the PGST team had only 1 day to unload, install, and configure the PGST, sensors, and COP to fully operational status. The short time period proved inadequate for the execution of the IV phases of the scenario. In order for the scenario to be executed correctly, the PGST should be able to be deployed, set up, and fully operational in days. The current configuration requires a minimum of 2 weeks before it would be fully operational.
Recommendation: Even though the PGST team members work tirelessly to accomplish the set up and configuration of the PGST, sensor, and COP, the short time frame proved inadequate to support the goals of the scenario. More time must be allowed to for the set-up of the equipment especially for deployment into an expeditionary environment. Due to unreliability of internet in the region, it is recommended to update the software before it is deployed to an area depicted in the scenario.

Observation 2: The PGST did not deploy high enough to overcome the dense vegetation in the region.
Feedback: With the PGST relying on line of sight for the majority of its sensors to work, the 86 foot maximum height was greatly limited by the vegetation of the area. The IR/EO and IR WAS camera's ability to penetrate the thickness of the vegetation limited the distance the cameras were able to see. As a result, the Thai operators were limited to observing pockets of clearings between the vegetation to search for potential VBIEDS using the camera

function alone. **NOTE:** Since the commercial radar was not fully operational, it could not be effectively evaluated to achieve any logical conclusions of its ability function in the highly dense vegetation.
Recommendation: The PGST is recommended to be placed on the highest areas of elevation or deployed in a manner that allows it to rise above the canopy of trees in the area. The increase in height will help with the sensors penetrating the density of the vegetation as well as allow for the increase in the quantity of open areas for observation. The maximum range of 20 km for small targets needs to be recalculated for areas of dense vegetation.

Observation 3: The COP was in the wrong language for the operators using it.
Feedback: With the COP and sensors all displaying the data in English, a communication barrier was introduced into the ability of the Thai officers in exploiting the full potential of the equipment. The Thai officers were limited in the ability of the translator's interpretation of the data being presented to him by the PGST team Subject Matter Experts. This was further compounded by the inability of the Thai officers to make changes to the COP due to the English keyboard.
Recommendation: Provide a translator with a background and experience level capable of translating the English explanation of the COP to Thai or develop a version of the COP in Thai.

Observation 4: PowerPoint presentations explaining PGST and COP were in English.
Feedback: The pre-brief of the PGST and its sensors was very limited in its ability to educate the Thai audience. The Thai audience appeared disinterested in the presentation as a result of the in ability to communicate effectively. The Thai audience was very professional in its acceptance of the communication barrier, but showed signs of disappointment.
Recommendation: Using the experiences of Afghanistan as a means to relate the uses of the PGST and the capabilities of its sensors proved in adequate in developing an understanding of the potential of the system. Having the pre-brief translated into Thai and using examples related to the region and relevant to the experiences of the Thai is necessary for the communication barrier to be crossed. This will allow for an open discussion of the PGST to occur before the scenario is executed.

Observation 5: Training was inadequate for the time period allowed. COP relied heavily on experienced operators to be effective.
Feedback: Due to the complexity of the COP and the coordination of using the PGST and it multiple sensors, the learning curve of the Thai operators was too steep for the technology to be properly executed. This compounded with the communication barrier of the translators and the equipment in English. The scenario was limited in its ability to effectively demonstrate the technology.
Recommendation: Since the PGST and capability of the sensors is limited to the experience and ability of the personnel operating it and in interpreting the sensor data, a multi week training program should be established for a set of Thai operators before the exercise is executed. The Thai operators should be taught how to operate the PGST the same as an American operator. These same Thai operators should be than used to demonstrate the technology during Exercise Crimson Viper. Using the "Train the Trainer" approach, the communication gap between English and Thai can be overcome resulting in a higher quality of qualitative data in the form of user feedback.

Observation 6: Interoperability of the COP was limited to the ability of the compatibility of the COP software to interact with foreign technologies.
Feedback: After each phase of the scenario, an informal AAR was conducted as a means to evaluate how the scenario could be improved. The interoperability of the PGST, sensors, and COP was a recurring topic of discussion between the Thai operators and the PGST team. The Thai operators had an issue with the COP's interoperability with Commercial off the Shelf (COTS) equipment provided by the RTA. The Thai operators explained how different sensors and cameras were readily available for them to access, and they would like to use their technology with the PGST and COP.
Recommendation: For the next Exercise Crimson Viper, recommend introducing lower levels of technology to be incorporated with the PGST and COP demonstration. The Thai operators saw the potential of the PGST and sensors for their missions, but were frustrated in the inability of the PGST and sensors to adapt to the resources available in their region. All 11 Thai operators showed great interest on how COTS equipment could be used in the scenario.
Note: Due to the delays in receiving the equipment from Customs and the inadequate set up time before the execution of the scenarios, evaluation of the PGST and its associated sensors was limited. Reliability of the equipment cannot be evaluated as a result of the PGST and sensors not being fully set up and configured. Maintainability of the PGST and sensors was not evaluated either for the same reasons.

Objective 2: Assess effectiveness of the PGST and associated sensors for counter-IED missions.

Observation 1: Address whether the IR360 was effective in detecting suspicious vehicle activities.
The IR 360 was partially effective in detecting suspicious vehicle activities. With the height of the PGST limited to 26m, the IR360 was only able to detect vehicles in the field of view with limited vegetation density.

Observation 2: Address whether the commercial radar was effective in detecting suspicious vehicle activities.
The commercial radar was not operational until the 2nd half of exercise on the 23rd of September. At that time the PGST team worked to configure the radar to operate at its full capacity. On the 24th of September, the PGST team uploaded an updated version of its software, but was unable configure the radar to work correctly for land contacts. PGST was not evaluated using the commercial radar due to inadequate time to configure system to fully operational status.

Observation 3: Address whether the IP camera was used/needed to classify and identify vehicle IED threats compared to the EO/IR camera.
IP camera was not used to classify and identify vehicle IED threats. Due to the limited field of view resulting from the dense vegetation, the EO/IR camera was primarily used to detect VBIEDs.

Figure 70: EO/IR Camera capturing VBIED

Observation 4: Address whether the EO/IR camera enabled users to classify and identify vehicle IED threats.
The EO/IR camera was able to classify the VBIEDS on a limited basis. With the majority of the sensors on the PGST not functioning correctly, the Thai operators were only able to detect the VBIEDs if it drove past the camera's field of view while they were looking.

Observation 5: Address whether the information from the sensors effectively fed the PGST COP.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.
The only reliable sensor was the EO/IR camera. The camera was very effective in its ability to track targets, but relied heavily on the operational experience level of the operator. If the operator did not know a target was in a particular sector of view, the target would never be monitored by the TOC or noticed on the COP.

Observation 6: Address any lessons learned in employing the PGST sensors to detect, classify and identify vehicle IED threats (e.g., better locating the UGS, cameras, etc with respect to the watch box).
Despite the PGST teams tireless efforts to configure the PGST and its associated sensors to operate as designed, inadequate time was provided for them to be successful. The RTOC was in very rough shape and desperately needed to be sent to a repair depot for maintenance. The commercial radar should have had the software uploaded for the scenario it was going to support (land or water) before deployment to the exercise. Spare parts for the equipment need to be included in the shipping list. Different countries have different standards and cannot be relied upon when an emergency arises.

Figure 71: Smart Phone capturing picture of VBIED

Figure 72: VBIED as displayed in the COP

Objective 3: Assess effectiveness of the COP feed in the JOC for counter-IED missions.

Observation 1: Address whether the information from the sensors effectively displayed on the COP in the JOC.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 2: Address whether the COP provided timely, accurate, complete, and relevant information to identify vehicle IED threats.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. Each picture captured for the COP had

to be staged for it to be captured for each scenario.

Observation 3: Address whether the COP provided timely, accurate, complete, and relevant information for the JOC to respond to a vehicle IED threat.
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Objective 4: Assess suitability of the COP feed in the JOC for counter-IED missions (Usability)

Observation 1: Address whether the COP feed in the JOC was intuitive for observing PGST sensor feeds and determining sensor target location (where the sensor is looking).
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated. Implementing the "Crawl, Walk, and Run" approach to training allowed for the Thai operators to operate the equipment, but was limited in their ability to expand their use past simply moving the cameras. The communication barrier between English and Thai compounded with the sensors not operating to full capacity compounded the difficulties in integrating the COP to the scenario. NOTE: When all 11 Thai operators were asked this question, all 11 unanimously stated they did not feel the technology as set up was effective in supporting C-IED missions. All 11 stated it was better suited for the first responder's mission.

Objective 5: Assess the mission impact of the COP feed in the JOC.

Observation 1: Did the JOC have situational awareness of potential IED threats in the watch box?
Due to the inadequate set up and configuration time, the PGST team was unable to set up the sensors to allow for them to be effectively evaluated.

Observation 2: Did the JOC provide information on the vehicle IED threat to the QRT (such as a license plate or screen capture) or did the QRT smartphone user get the information from the Mobile COP live feed?
This observation was unexecuted due to difficulties with Smart Phone operation and lack of time to adequately train Thai personnel who operated them. The technology of the Smart Phone only allowed for it to transmit data. The Smart Phone was sporadic in its ability to achieve connectivity with the JOC and did not allow for information transmitted from the JOC. The Thai operators spent more time looking at the Smart Phone trying to make it work and less time paying attention to the situation around them.

Conclusions
Due to the short set up time available, issues with equipment working, no spares available for repair, and limited ability to trouble shoot software issue that occurred while trying to integrate the sensors to the COP, the PGST operated independently from the first responders in the scenario and focused on accomplishing the C-IED mission. The tireless commitment and dedication of the members of the PGST team in setting up and troubleshooting the issues that arose daily with the equipment was pivotal to the daily success of the scenarios. The patience of the 11 Thai operators and their corresponding contributions were instrumental in the execution of each phase of the scenario. Even with the "Crawl, Walk, Run" approach to executing the C-IED

mission, only the first two of the four phases were executable and provided limited amounts of credible data for analysis.

With only 2 of the IV phases of the scenario executable, the qualitative information gathered during the exercise exposed many weaknesses of the PGST. The estimated 2 week time period required to deploy, set up, and configure the PGST, sensors, and COP proved to be too long for a scenario requiring a rapid response. A combination of training, planning, and equipment preventative maintenance would be required in order to accomplish this type of a scenario. A longer set up time would be allowed for IED scenarios due to the techniques, tactics, and procedures already established to counter this type of threat.

Even with the inadequate time for set up, the environment the PGST was deployed exposed limitations of the PGST, sensors, and COP. The PGST's effectiveness increases the higher it is placed on the region it is deployed. Setting up the PGST requires material handling equipment capable of clearing an area for deployment as well as equipment capable of logistically loading, moving, and unloading the PGST, sensors, and CGS. With the scenario depicting a typhoon sweeping through the area, the mostly rural area would have encountered mass flooding and washed out roads. The effectiveness of the COP is limited to the ability of the sensors to pick up contacts. The effectiveness of the sensors themselves to pick up contacts is limited by their ability to penetrate the vegetation of the region. With the PGST height of only 86 feet and sensors that are limited on the line of sight for effectiveness, the PGST tower itself proved to be a weakness in its ability to support providing information to the COP.

The dense vegetation in the region exposed yet another weakness of the PGST and sensors. Assuming the PGST, sensors, and COP were fully operational in the inadequate time provided, the ability of the Thai operators exposed how important a proficient crew is needed in manning the RTOC. The PGST team and Thai operators were able to overcome many of the obstacles encountered in operating the RTOC during the "crawl" phase of the scenarios, but once the RTOC was turned over to the Thai operators. During the "walk" phase of the scenarios, the lack of training among the Thai operators became very prevalent. The experienced PGST team was able to limit restrictions presented by the vegetation of the area, but the inexperienced Thai operators encountered challenges incorporating the sensors with the COP and relaying that information to personnel in the field. The need for training personnel and providing them the opportunity for gaining experience with the COP's multitude of capabilities exposed the limitations of the COP itself. The technology of the PGST and the COP's ability is only effective as the operators manning them.

When the Thai operators were asked if they felt the scenario was too difficult, all 11 agreed it was set at an appropriate level of difficulty. All 11 Thai operators felt confident in operating the system but would like to see sensors configured to the PGST. The Naval officers wished to see the commercial radar work for the water, but the RTA officers wanted to see the commercial radar set up for land contacts. All personnel wished to see more C-IED technologies and expressed interest in seeing the Under Ground Sensors (UGS) incorporated into the COP. In conclusion, the PGST, sensors, and COP showed much potential for C-IED operations, but exposed many weakness as well. The COP proved to be only as effective as the sensors supplying it data, but is hindered more by the quality of training of the personnel who operate it. Set up time of the whole system requires extensive planning and logistical coordination for continued mission success.

APPENDIX A: CV14 PHASE IV AAR SUMMARY

Thai requested technologies for extended assessments:

- ePoP
    - For use in the south and boarder, possibly used for jamming as well
- PGST

Lessons Learned Logistics and Admin

- More time for logistics planning and execution
    - Logistics lead must participate in site surveys
- Arrange meetings with all staff involved, including embassy, GSO Office, Thais, and US before arrival of shipments to help expedite getting technologies out of customs
    - Possibly during FPC
- More Liaison officers to help bridge the language barrier, every group should have a Liaison officer
- Name tags the Thai personnel wore was very helpful, it helped clarify rank, the US should have similar nametags (we can send to Thailand beforehand and they can produce them)
- Setup and prep time was a big issue at this CV. Some technologies that should have been combined were not due to time constraints.
- Popup or military tents should be on standby in case of rain or other weather issues. It would have probably been a good idea to have tents in the first place to more accurately simulate an HADR HQ
- Detailed list of equipment we need at destinations when shipping, ex. Forklift
- A liaison officer to help with supplies. They can probably find things in a few minutes that take us a few hours.

Notes

- Requests for special invitations for visitors should only be made if the visitors are confirmed.

APPENDIX B: HADR/MEDICAL AND C-IED SCENARIOS

HADR/Medical Scenario

Scenario Lead: LCDR Carrizosa

Objective: Support disaster response operations

Technologies

- Soldier Transportable Alternative Energy Storage System (STAESS) (24 PV modules, max 32)
- Smart Portable Power Solution (PPS) (8 PV modules, max 24)
- Renewable Energy Area Lighting (REAL) Big (10,800 lumens)
- REAL Small (3,800 lumens)
- First Response 5000 gpd (19,000 Lpd) Water Purification System
- Smart-Direct Assessment in Real Time (Smart-DART) Gene-Based Detection Kit
- Portable Thermoelectric Cooler/Refrigerator
- Emergency Pop-Up Phone and Power Network (ePoP)
- Persistent Ground Surveillance Tower (PGST) with Outdoor Wi-Fi Access Points and VSAT
- Android smartphones with ePoP and PGST Mobile Common Operating Picture (COP) software

Capabilities

- Determine polluted water sources (Smart-DART)
- Purify water (First Response)
- Illuminate response operations (REAL)
- Notify population of relief sites (ePoP, PGST Wi-Fi, VSAT and mobile phones)
- Update higher headquarters with response operations (ePoP w/ BGAN, PGST Wi-Fi w/ VSAT and mobile phones)
- Distribute water and medicine from relief sites (Coolers)
- Power technologies at a Joint Operations Center (JOC) (STAESS, Smart PPS)

Users

- CV14 FWD JOC & Staging Area/PGST COP view-only, Cooler, REAL Big: LtCol Fisher and LTC Arm (assisted by Anna Root)
    - STAESS: LCDR Carrizosa and 2-3 STAESS/Smart-PPS Users
    - Cooler: Anna Root and 1-2 Users
    - REAL Big: LCDR Carrizosa and 1-2 REAL Users
- PGST Wi-Fi and COP operations: Tom Barychewsky and 2 Users
- Survey Team: MAJ Christensen
    - Smartphone: 2-3 Users
- Water Team: Frank Duran
    - First Response: 2-3 Users
    - Smart PPS: 2-3 STAESS/Smart-PPS Users
    - REAL Small: 1-2 REAL Users

- Smart-DART: MAJ Christensen and 3 Users
- ePoP: MAJ Christensen and 2-3 Users
- CV14 REAR: Jessica Hiraoka

Setup

- Salinity meter and test strips
- Fresh water source for water purification operations
- Water containers
- Bottled water as medicine
- Extension cords

Tasks

1. Conduct Site Survey
    - Identify HLZ and supply staging area
        - Collect and send photos, GPS coordinates, and approximate measurements of HLZ and staging area to CV14 FWD JOC
    - Identify water port and capabilities
        - Collect and send photos, GPS coordinates, and pier capacity to CV14 FWD JOC
    - Meet with local officials at affected area, survey damage
        - Collect and send photos, GPS coordinates of damaged area to CV14 FWD JOC
        - Collect and send village leader POC information to CV14 FWD JOC
    - Determine appropriate water source for First Response operations
        - Measure water salinity and take test strip samples
    - Determine viability of water sources for general population drinking water
        - Take Smart-DART readings and send results back to CV14 REAR for interpretation
2. Conduct Water Purification and Distribution Operations (day ops plus one night op)
    - Purify water with First Response during day/night operations
    - Smart PPS powers First Response day/night operations
    - REAL Small illuminates First Response night operations and provides night security
    - Send status updates to CV14 FWD JOC
3. CV14 FWD JOC update the local population of services
    - Use ePoP and PGST Wi-Fi networks
    - Notify public of CV14 HADR response services via ePoP software and various social media and text messaging apps (e.g., Twitter, Facebook, Facebook Messenger, Viber, Line)
        - Locations of water source contamination, warning and recommended actions (i.e., boil water before use) per local government

        - Locations of water purification operations, operating hours, capacity (gpd/Lpd), distribution (x gal or y Liters per person) and to bring water containers when possible
        - Locations of supply distribution operations and types of supplies available (e.g., blankets, tarps, food, etc) including medicines

4. CV14 FWD JOC update CV14 REAR of CV14 HADR response operations and CV14 status over VSAT
    - Conduct morning meetings via Skype at 0900 Bangkok time/1600 HST
    - Email daily SITREPs to CV14 REAR by 2300 Bangkok time/0600 HST
    - Post Scenario data to Dropbox

Counter-IED Scenario

Scenario Lead: LCDR Ferron

Objective: Detect/identify motorcycles carrying IEDs and/or IED operator

Technologies

- Persistent Ground Surveillance Tower (PGST) and Components
    - Deployable Tower Trailer
    - Ground Control Station and Remote Tactical Operations Center (RTOC)
    - EO/IR PTZ Camera
    - IR 360 Wide Area Surveillance Camera
    - Commercial Radar
    - Android Phones w/ Mobile COP
    - Outdoor Wi-Fi Mesh Network
    - Unattended Ground Sensors (UGS)
    - IP Camera
    - Very Small Aperture Terminal (VSAT)

Capabilities

- Detect vehicles, motorcycles, and people (PGST radar)
- Detect vehicles, motorcycles, and people (UGS)
- Provide near real-time imagery from tower, ground cameras and smartphone users (PGST GCS/RTOC)
- PGST GCS operator and smartphone users classify/identify potential threats

Users

- 6-7 PGST users total
- CV14 FWD JOC/PGST COP view-only: LtCol Fisher and LTC Arm (assisted by Anna Root) and 1-2 PGST Users
- PGST Wi-Fi and COP operations: Tom Barychewsky and 1-2 PGST Users
- Quick Reaction Force (QRF)/Smartphone: LCDR Carrizosa 2-3 PGST Users
- CV14 REAR: Jessica Hiraoka
- Motorcycle Role Players: 2-3 PGST Users

Setup

- Dig ground 3” for UGS - Shovel

- Motorcycle(s) (DSTD)
- Motorcycle rider(s) (DSTD, MAJ Christensen)
- IED props (DSTD)

Tasks

1. Create watch boxes at previous IED sites (Intersections A and B)
2. Establish normal activity patterns
    - Monitor normal traffic along main route consisting of cars, trucks, motorcycles, etc
        - PGST COP shows vehicles (cars, trucks, and motorcycles) detected by PGST radar and IR 360
        - PGST operator verifies detections of cars, trucks, and motorcycles using EO/IR camera
    - Monitor local activity in the area (delivery trucks, farming, and other activities with vehicle/personnel stoppages along the road)
3. Monitor the area for suspicious activity
    - Motorcycle rider stops along side of road in watch box
        - PGST radar indicates a vehicle stopping in watch box
        - PGST UGS indicates a vehicle detection in watch box
        - PGST EO/IR camera slews to watch box to classify/identify the vehicle as a motorcycle
    - Identify motorcyclist
        - CV14 FWD JOC identifies motorcyclist on PGST EO/IR feed
        - CV14 FWD JOC operator notifies QRF (smartphone user)
        - QRF looks at smartphone PGST feed for motorcycle/motorcyclist photo
        - QRF detains motorcyclist
4. CV14 FWD JOC update CV14 REAR of CV14 C-IED operations and CV14 status over VSAT
    - Post Scenario data to D

APPENDIX C: HADR AND MEDICAL SCENARIO CHECKLIST

Scenario Prep: Use only one network, ePoP or PGST, for the entirety of each scenario run.

Conduct Site Survey		
Task	**Technology**	**(X)**
HLZ Site: Collect/send photos, GPS coordinates, and est. measurements of HLZ and staging area to COC	Smartphones using ePoP or PGST	
Water Port Site: Collect/send photos, GPS coordinates, and pier capacity to COC	Smartphones using ePoP or PGST	
Meet with local officials at affected area, survey damage Collect/send photos, GPS coordinates of damaged area to COC	Smartphones using ePoP or PGST	
Meet with local officials at affected area, survey damage Collect and send village leader POC information to COC	Smartphones using ePoP or PGST	
Survey Water Source for First Response Measure water salinity and take test strip samples	(First Response testing material)	
Drinking Water Viability Take Smart-DART readings and send results back to the rear for interpretation	Smart-DART	
Conduct Water Purification and Distribution Operations (Day ops + 1 Night op)		
Task	**Technology(s)**	**(X)**
Setup STAESS to power First Response	PPS, First Response	
Purify water with First Response	First Response	
Setup REAL Big in water purification area	REAL Small, First Response	
Use mobile devices to relay status to COC	Smartphones using ePoP or PGST	
FWD COC Update the Local Population (using social media and text, e.g. Twitter, FB, FB Messenger, Viber, Lime)		
Task	**Technology**	**Task**
Notify locations of water source contamination, warning and recommended actions (i.e. boil water) per local government	ePoP or PGST	
Notify locations of water purification operations, operating hours, capacity (GDP/Lpd), distribution (x gal. or y liters per person) and to bring water containers when possible	ePoP or PGST	
Locations of supply distribution operations and types of supplies available (e.g. blankets, tarps, food, etc) including medicines	ePoP or PGST	
FWD COC Update the Local Population of Service		
Task	**Technology**	**(X)**
Post Scenario data to Google Drive		

APPENDIX D: COUNTER-IED SCENARIO CHECKLIST

Scenario Prep: Create Watch Boxes at Previous IED sites (Intersections A and B)

Monitor Normal Traffic Route Consisting of Cars, Trucks, Motorcycles, etc.		
Task	**Technology**	**(X)**
Identify vehicles with PGST COP, classified by PGST Radar and verify with EO/IR camera	PGST	
Monitor Local Activity in the Area for Suspicious Activity		
Task	**Technology**	**(X)**
Monitor delivery trucks, farming, and other activities vehicles/personnel stoppages along the road	PGST	
Motorcycle rider stops along side of road PGST radar indicates motorcycle stopping in watch box	PGST	
Motorcycle rider stops along side of road PGST UGS indicates motorcycle detection in watch box	PGST	
Motorcycle rider stops along side of road PGST EO/IR camera slews to watch box	PGST	
Identify motorcyclist FWD COC identifies motorcyclist on PGST EO/IR feed	PGST	
Identify motorcyclist FWD COC operator notifies QRF (smartphone user)	PGST	
Identify motorcyclist QRF looks at smartphone PGST feed for motorcycle photo	PGST	
Identify motorcyclist QRF detains motorcyclist	PGST	
FWD COC update CV14 Rear of C-IED ops and CV14 status over VSAT		
Task	**Technology**	**(X)**
Post Scenario data to Google Drive		

ANNEX A : CV14 PHASE I REPORT : COLD FORM STEEL

CRIMSON VIPER 2014
TECHNOLOGY INSERTION

SCIENCE AND TECHNOLOGY
PHASE I
VENUE REPORT

KINGDOM OF THAILAND
MAY 2014

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LIST OF FIGURES

ACRYONMS

AOR	Area of Operations
CARAT	Cooperation Afloat Readiness and Training
C-IED	Counter-Improvised Explosive Device
CFS	Cold Form Steel
CMU	Concrete Masonry Unit
CO	Commanding Officer
CONOP	Concepts of Operation
CV14	Crimson Viper 2014
DoD	Department of Defense
DoN	Department of the Navy
DSTD	Defence Science and Technology Department
DV	Distinguished Visitors
EXWC	Engineering and Expeditionary Warfare Command
FSR	Field Site Representative
HADR	Humanitarian Assistance and Disaster Relief
IBC/IRC	International Building and Residential Codes
MCO	Major Combat Operations
MDA	Maritime Domain Awareness
MOD	Ministry of Defence
NAVFAC	Naval Facilities
NECC	Naval Expeditionary Combat Command
NMCB	Naval Mobile Construction Battalion
NPS	Naval Postgraduate School
PACOM	Pacific Command
RTN	Royal Thai Navy
S&T	Science and Technology
Seabees	US Naval Construction Battalion
SED	Systems Experimentation Division
TBD	To Be Determined
THAI TAC	Thai-American Consultations
TSC	Theater Security Cooperation
TTP	Tactics, Techniques, and Procedures
U.S.	United States
XO	Executive Officer

INTRODUCTION

Purpose

The purpose of experimentation in Crimson Viper 2014 (CV14) is to introduce leading edge technologies and proposed Concepts of Operation (CONOP) to relevant training audiences while assessing candidate technologies and providing operational feedback to the science and technology (S&T) community. Additionally, CV14 Phase 1 provided engagement opportunities with the Thai Armed Forces and civilian partners involved in S&T. This report covers the Naval Facilities (NAVFAC) Engineering and Expeditionary Warfare Command (EXWC) Systems Experimentation Division (SED) activities on 23 May 2014. For the remainder of this document the Naval Facilities Engineering and Expeditionary Warfare Command Systems Experimentation Division (NAVFAC EXWC SED) will simply be referred to as the SED.

Background

The Crimson Viper Field Experiment is conducted annually between the Royal Thai Ministry of Defence (MOD) Defence Science and Technology Department (DSTD) and US Pacific Command Science and Technology Office (USPACOM J85). Crimson Viper is executed under the ambit of the Thai-American Consultations (THAI TAC) Joint Statement. Crimson Viper was discussed during THAI TAC XVI on 9-11 April 2014 under Working Group 4 for “Relationship Building, Coordination and Collaboration at All Levels” under subgroup 4.2 for Science and Technology.

CV14 will include information sharing and joint experiments featuring expeditionary construction, Counter-Improvised Explosive Device (C-IED), and maritime domain awareness (MDA) technology areas. Phase 1 of CV14 on 23 May focused on the demonstration of the Cold Form Steel (CFS) technology in Sattahip, Thailand. The US Naval Construction Battalion (Seabees) are developing expeditionary construction techniques using CFS portable roll former technology to support humanitarian assistance/disaster relief (HADR) missions. These techniques will be demonstrated and assessed in Thailand, Malaysia, and the Philippines during the Cooperation Afloat Readiness and Training (CARAT) exercise. The remaining phases of CV12 are currently To Be Determined (TBD) based upon the developing political situation in Thailand.

CV14 Phase 1: Cold Form Steel Demonstration and Assessment

Purpose

The purpose of CV14 Phase 1 was to demonstrate the operational effectiveness of CFS portable rollformer construction technology in support of contingency construction operations by U.S. Navy Seabees during the CARAT 2014 exercise.

Background

Naval expeditionary forces support forward warfighters with the full range of general engineering and military construction including erecting vertical structures, repairing or installing electrical, plumbing, climate control and power generation systems. They work routinely accomplished in remote areas of developing countries where logistics support is distant and supporting infrastructure almost non-existent. Current construction product line requires acquisition, transport, and storage of multiple line items of Class IV construction materials, personnel and equipment to perform the work and provide onsite habitat and support for the construction crew.

Costs for fuel, storage and transportation of material, security and support of personnel are high, and the time required to complete a project, expressed in man-days of construction, is a key driver of personnel support costs. Deployed units are often put at risk creating an urgent need for TTPs and construction products/methods to reduce this exposure. Private industry has produced alternatives to current materials and design, such as "FRAMECAD." DoD and DoN have set ambitious goals for reductions in energy consumption and more efficient construction materials and methods would significantly contribute to meet those goals. As a result of this emergent need, the Seabees have begun developing expeditionary construction techniques using CFS portable roll former technology to support their missions.

Objectives

The objectives of Phase 1 of CV14 were to:

- Observe how CFS technologies and techniques adapt to expeditionary construction techniques in the PACOM Area of Operations (AOR)
- Investigate the impact on the Class IV construction items required
- Evaluate impact on man-days required to complete a construction project
- Investigate benefits of using this type of technology as a replacement or addition to current construction materials and methods
- Investigate impact on the quantity, size, or a change in the configuration of expeditionary construction equipment

Locations

Sattahip Naval Base

Sattahip is a district in the province Chonburi, Thailand. It is located at the southern tip of the province, close to the tourism center Pattaya. The Sattahip Naval Base is the largest base of the Royal Thai Navy and is home to the His Thai Majesty's Ship (HTMS) Chakri Naruebet, the Navy's sole aircraft carrier

Figure 1: Detailed Project Location Map, Sattahip Thailand

Participants

Defence Science and Technology Department (DSTD)

DSTD is a department of the Thai Ministry of Defence that focuses on Science and Technology initiatives? During CV14 DSTD served as the executive agent for S&T collaboration with USPACOM.

Naval Mobile Construction Batallion 1 (NMCB1)

"The First and the Finest," Naval Mobile Construction Battalion ONE, has a long, proud and distinguished history that reaches back to the early days of World War II. The NMCB1 served as the test unit during CV14 Phase 1. They participated in training events and construction demonstrations of the CFS technology in conjunction with the efforts during the CARAT event.

NAVFAC, EXWC, SED

The SED coordinates warfighter technology demonstrations and assessments throughout the Pacific. Responsibilities include planning the evaluation, developing the critical operational issues, developing data collection forms and questionnaires, analyzing data, and reporting the results.

Figure 2: NMCB1 and SED FSR, Todd Jonas

Naval Postgraduate School (NPS)
NPS provides relevant and unique advanced education and research programs to increase the combat effectiveness of commissioned officers of the Naval Service to enhance the security of the United States. The NPS was the project coordinator and execution authority for the contract to lease the Mobile Factory that was used in the assessment.

Navy Expeditionary Combat Command (NECC)
The NECC serves as the single functional command for the Navy's expeditionary forces and as central management for the readiness, resources, manning, training, and equipping of those forces. The NECC is the Cold Formed Steel project's sponsor and commissioned the assessment.

Technology Description

The following section provides a brief description of the CFS technology that participated in CV14 Phase 1.

CFS is a commercial-off-the-shelf technology used in the construction industry. The technology provides an onsite roll formed steel factory providing light gauge steel structural members, roofing, and cladding capability. The system reduces waste and logistical tail as compared to conventional expeditionary construction.

CFS enables sea based delivery of vertical engineering capability for Major Combat Operations (MCO), HADR, and Theater Security Cooperation (TSC) missions where onboard available space is restricted, specific project details are unknown and local procurement options are

limited. CFS also reduces duration/cost of Humanitarian Civic Assistance (HCA) missions (Balikatan & Cobra Gold) from the traditional 4-6 weeks down to the optimal 2-3 weeks that is desired by Supported Commanders and fiscal realities. CFS enables Off-Site, Rapid Production to support dispersed project sites that historically are limited by material procurement lead-times and is an extremely long lasting, sustainable, and cost effective alternative to timber and Concrete Masonry Unit (CMU) construction that is already in International Building and Residential Codes (IBC/IRC) and in local code for several U.S. PACOM countries.

Figure 3: Cold Form Steel Components

DSTD Advanced Party (ADVON) Visit

The SED hosted an ADVON party at RTN Sattahip Naval Base on 22 May. The party consisted of COL Nattapol Junsorklin Director, Defence Science and Technology Policy Division and LTC Armani Ketudat, Ministry of Defence, Office of Policy Staff, DSTD. The SED Field Site Representative (FSR) provided a presentation of technology, tour of the worksite, and answered questions regarding the project. The build-team on 22 May consisted of 13 Seabees and 7 Thai marine builders (Figure 4), who were involved with the building and raising of the façade.

Figure 4: 4 Thai Marine Builders and 2 Seabees

ADVON Day Site Activity Summary

- The Thais did not build concrete pad prior to NMCB1 arrival.
  - This impromptu change to the build plan forced the NMCB1 team to individually design on-the-fly each of the storefront façade's steel members one-at-a-time
  - No provision for this from pre-existing design.
- Storefront was uniquely shaped –included a sloping roofline, out-of-plumb walls, and an interfering central horizontal beam that split the decreasing height main wall into two sections.
- Though previously trained on the technique, this method was only intended to create the occasional piece to replace damaged members.
- Interior members (w/exception of façade) were programmed into the machine on a sequential basis. As expected, this led to much more waste than a pre-programmed design would create.
- As expected, every time a member was fabricated, no matter how small, the steel within the machine that was behind the cutoff point would then have to be expelled and cut off.
- This created approximately 800-1000 feet of waste for 440-feet of usable steel
- Reachback support to the vendor FRAMECAD was tested for the first time in the field in solving the one-off member fabrication waste issue.
- Reachback accessed using Mobile Hot Spots and Skype to interface with FRAMECAD remote technicians, who were sent photos and dimensions of the technical problem.
- The vendor then designed and forwarded back to the field team a new design file for fabrication machine, all within an hour.
- New façade for storefront was then fabricated and assembled in approximately 2-hours.
- NMCB1 fabricated the remaining ceiling, left wall, the façade, and primary electrical installation prior to lunch.
- Seabees ground off protruding reinforcing rod leftover from the previous day's demolition of façade opening's perimeter brickwork.

- Builders completed the full left wall, ceiling steel, façade electrical, and installed 30% of the teak ceiling plywood.
- Measured steel length used in storefront:
    - Side Wall: 194’
    - Ceiling: 202’
    - Doorway Plug: 43’
    - Façade: 141’
    - Total steel used: 580’
    - Non-Façade steel used: 439’

Distinguished Visitors (DV) Day

The SED hosted an S&T DV Day at RTN Sattahip Naval Base on 23 May. The purpose of the event was to highlight the Cold Form Steel technology as part of CV14 and an effort to promote S&T collaboration between the Thai MOD and U.S. PACOM. The event played a key role in highlighting DSTD and SED collaboration on technology experimentation. The S&T Demonstration Day consisted of technology briefs and a technical demonstration of the CFS technology.

Figure 5: DV Day Participants

A contingent of ten Thai Army and Navy officers visited the worksite and were given tours of the job and equipment. Distinguished Visitors included LTC Tanisorn Limmun, from 1st Engineer Regiment, King's Guard, CAPT Yuthasak Suwanpha, from 1st Engineer Regiment, King's Guard, CAPT Chairat Pengkong RTN, from Naval Research and Development Office, CDR Aviruth Viangkhaew RTN, from Sattahip Naval Base Command, LTJG Somsak Marksap RTN, from Ordnance Division, Royal Thai Fleet, and ENS Surin Markjalearn RTN, from Engineer Battalion - Royal Thai Marines Corps.

Site Visit Locations

The DV Day participants visited a number of sites as part CV14 Areas visited by the DV day DSTD visitors included:

- **Power Supply Area** which contained a locally rented 30kW diesel generator, fuel drums, and fuel containment barrier
- **The Main Work Area** consisting of a covered area under an existing structure that NMCB1 used as a daily staging and sub-assembly work area.
- **The Primary Construction Site** was a refit of unimproved shell space A 3.5m x 7m. Unimproved shell space was refurbished by adding interior demising walls within the existing structure. An exterior façade wall and interior doorway fill-wall.
- **The Alternate Construction Site (**Concrete Pillars) was adjacent to the primary site. It consisted of an 8m x 16m grid of 12 3m tall concrete pillars that were to be modified by the Thais for use as a foundation for a future SOUTHCOM Hut. Frame members that were produced by NMCB1 were left for the Thais to assemble later.
- **The Equipment Laydown Area** was a side area for Tri-Con storage, Seabee generator, load bank, tools, etc.
- **The Mobile Factory** consisted of the CFS machine in a 20-foot ISO container, steel loading gantry, steel decoiler, and covered assembly area.

Figure 6: Build Site Operational Areas

DV Day Site Activity Summary

- Seabees erected two 10’ x 10’ canopies on the output end of the machine, and utilized a tarp to cover the gantry on the input end
  - Ensures that the decoiler would not get wet as this factory model was not designed for use in wet conditions.
- 1^ST steel coil expended and a new 10-gauge coil installed on the decoiler:
  - Radius, Inside: 10-3/8”
  - Radius, Outside: 19-7/8”

    - +30’ used from decoiler to through machine on coil start
- Basic training given to the Thai marine construction team on how to assemble the SOUTHCOM Hut sub-structures and the overall building, including recommendations how to tie the parts into their pre-existing concrete column foundation.
- NMCB1 completed building out the storefront and all parts of the 16’ x 16’ SOUTHCOM Hut. All SOUTHCOM Hut steel parts bundled and left for the Thais to construct at their convenience.

CV14 Phase 1 Summary

The Crimson Viper Field Experiment is conducted annually between the Royal Thai MOD, DSTD and US USPACOM J85. The purpose of experimentation in CV14 is to introduce leading edge technologies and proposed CONOP to relevant training audiences while assessing candidate technologies and providing operational feedback to the S&T community.

As a result of the emergent need to reduce energy consumption, reduce costs, and utilize more efficient materials and methods the Seabees have Seabees have begun developing expeditionary construction techniques using CFS. CFS is a commercial-off-the-shelf technology used in the construction industry. The technology provides an onsite roll formed steel factory providing light gauge steel structural members, roofing, and cladding capability. The system reduces waste and logistical tail as compared to conventional expeditionary construction.

The purpose of CV14 Phase 1 was to demonstrate the operational effectiveness of CFS portable rollformer construction technology in support of contingency construction operations by U.S. Navy Seabees during the CARAT 2014 exercise. CV14 Phase 1 was conducted in Sattahip, Thailand at the RTN Engineering Battalion Base. The project was coordinated and supported by DSTD, NMCB1, NAVFAC EXWC SED, NPS, and NECC.

On 22 May the SED hosted an ADVON party that included COL Nattapol Junsorklin Director, Defence Science and Technology Policy Division. The SED Field Site Representative (FSR) provided a presentation of technology, tour of the worksite, and answered questions regarding the project. The build-team on 22 May consisted of 13 Seabees and 7 Thai marine builders.

On 23 May the SED hosted an S&T Distinguished Visitors Day. The purpose of the event was to highlight the Cold Form Steel technology as part of CV14 and an effort to promote S&T collaboration between the Thai MOD and U.S. PACOM. The S&T Demonstration Day consisted of technology briefs and a technical demonstration of the CFS technology. Ten Thai Army and Navy officers visited the worksite and were given tours of the job and equipment. Locations visited included the power supply area, the main work area, the primary construction site, the alternate construction site, the equipment laydown area, and the mobile factory.

Overall, CV14 Phase 1 was a successful event for technology insertion and partner nation S&T collaboration efforts. The data collected from the Phase 1 experimentation event will help shape continued technology development for our warfighters and future SED efforts.

ANNEX B: CV14 PHASE II: IMPROVISED EXPLOSIVE DEVISE NETWORK ANALYSIS (IEDNA) SEMINAR SUMMARY

The US Naval Postgraduate School (NPS) IEDNA is a software analysis tool to track IED related events in space and time to define the IED threat network. The seminar will consisted of two parts. First, participants will identified IED components in the field and input data into the NPS database using Smartphones. Then, participants conducted IED network analysis of data processed using the NPS Lighthouse program.

Figure 1: IEDNA Data Collection

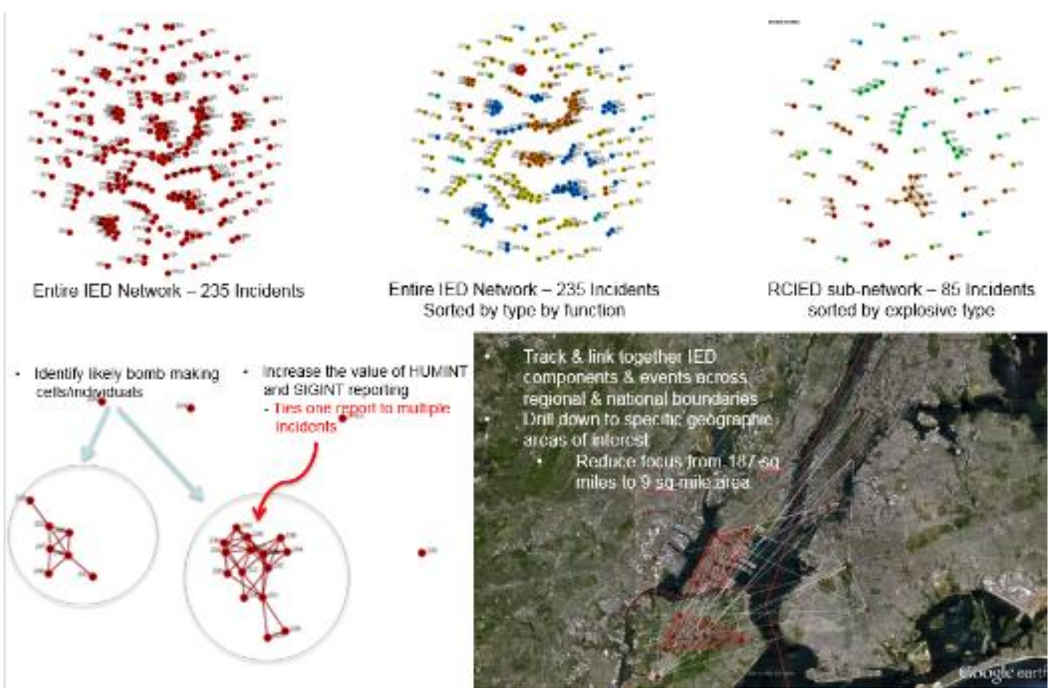

Figure 2: IEDNA Data Exploitation

Schedule

Date	Event	Location	Participants
6 Jun	Data Collection	Army Air Defense Command	20 officers from Explosive Ordnance Detection (EOD) and ISOC operations units
9-10 Jun	Data Analysis	DSTD Computer Lab	20 officers from ISOC and Military Intelligence Command, Directorate of Operations

The CORE Lab participated in an interagency Attack the Network Expert Academic Exchange (AtN EAE) hosted by the RTAF and led by the USARPAC CIED Fusion Center. Interagency partners included the Federal Bureau of Investigation (FBI), JIEDDO, AWG, NPS, DTRA, MARFORPAC, and the Washington State National Guard. The CORE Lab presented material focused on the application of social network analysis methodologies in order to illuminate IED networks. The CORE Lab also provided a demonstration of the utility of structured field-data collection (mobile component) for EOD units on the tactical objective and developed a working prototype (in the Thai language) for Thai EOD units to use in the field.

Following the AtN EAE, the CORE Lab conducted a three-day education course with the Defense Science Technology Directorate of the Ministry of Defense as a part of Phase III of Crimson Viper. Day one provided an IED^{NA} overview to senior intelligence officers, EOD techs, and police officers from the southern provinces. An Army officer from the Pattani Bomb Data Center provided the CORE Lab with a detailed nine-year data set of IED events from the three southernmost provinces. Day two and three of the training were spent in the classroom with RTAF intelligence analysts teaching the IED^{NA} methodology and hands-on computer labs. A portion of the data set provided by the Pattani Bomb Data Center (translated by a Thai speaker on the CORE Lab team) was used as the baseline for the analytic demonstration conducted on Day three to emphasize the utility and compatibility of the IED^{NA} methodology with real world data.

Figure 3: CV14 Phase II participants receive IEDNA methodology training

Finally, the CORE Lab updated leadership and staff members at the U.S. Embassy's Open Source Center – Southeast Asia Bureau on two joint research projects. The first project seeks to translate and structure nearly 1,200 pages of IED post-blast reports from Thailand's border

provinces from 2004-2010. These data will be used (in conjunction with the newly acquired data set mentioned above) for student and faculty research papers for publication. The second project utilizes CORE Lab social media exploitation expertise in identifying actors influential in disseminating information about the insurgency in the south and the content of that messaging as it relates to potential threats.

Conclusions

Phase II of CV14 was a successful training opportunity that provided a collaborative platform for information sharing and relationship building. All participants gained valuable exposure to capabilities that could potentially support future IED focused operations. The RTA participants provided the following feedback regarding the technology and seminar:

- The intelligence analysts thought the software was a great capability and liked having the level of detail about the IEDs to be able to do IED network analysis.
- Getting that level of detail did not match the RTAF EOD guys' practices. The EOD teams usually detonate the IED in place instead of trying to diffuse it and study it. It is safer and more expedient. For the IED network analysis you have to enter in what materials the IED is made of, how it is constructed, etc, which you can't get after you blow it up.
- The Thai police liked the tools. They attended previous training sessions and sent some repeat trainees to the training events.

The seminar resulted in the following objectives for the way ahead:

- The CORE Lab will work with a Defense Analysis student from the Royal Thai Army who will use the data obtained from this trip and IED^{NA} methodology in his coursework.
- The CORE Lab will conduct research on the IED problem set with the goal of publishing the findings in a peer-reviewed journal.
- The CORE Lab will seek sponsor funding to continue research and development on IED Network Analysis.

ANNEX C: CV14 PHASE III: STANDOFF COVERT EYE-SAFE EXPLOSIVES DETECTION SYSTEM (SCEEDS) SUMMARY

SCEEDS provides stand-off detection of explosives and explosive residue at ranges up to 200 meters without the need for laser eye protection. The SCEEDS demonstration in Exercise HANUMAN GUARDIAN during 16-20 June and as part of CV14 the following week is sponsored by the US Army Research Development and Engineering Command (RDECOM) Forward Element Command (RFEC) Pacific.

Figure 1: SCEEDS

Schedule

Date	Event	Location	Participants
24 Jun 1000-1600	Knowledge Seminar and Systems Demo	Research and Development Centre for Space and Aeronautical Science and Technology, RTAF	50 officers from defence F&D units and institutions network
26 Jun 1300-1600	Systems Demo	2^{nd} Infantry Battalion, 1^{st} Infantry Regiment, King's Own Guard	60 officers total IED Detection Device Unit Directorate of Logistics Directorate of Operations Ordnance Department

Event Summary

- Timeline : 24 - 26 June 14
- Length : 2 days
- Location : Research and Development Centre for Space and Aeronautical Science and Technology, RTAF (RDC)
- Chemical to detect : potassium perchlorate and ammonium nitrate provided by RDC
  POC : Andy Wood

Figure 1: SCEEDS 24 - 26 June 14 at RTAF

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Figure 2: SCEEDS 24 - 26 June 14 at RTAF

CV14 Phase III Technology Feedback

- The system is not mature enough because the machine needs direct line of sight to the substances to make a positive ID, it needs a substantial amount of the substance, and the sample has to be stationary, not moving. So for example, it is hard to detect vehicles transporting the substances because normally they would be enclosed, not exposed during transit, and they are moving. The amount of substance is a problem too because to detect a person who has been working with those chemicals, their hands or clothing would have to be really dirty.